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ERRATA

Page 336, line 6
for twelve read fourteen

Page 336, line 8
delete “the *Gramineae* by four,”

Page 339, line 6
for *Gramineae* read *Cyperaceae*

Page 340, last line
replace the , by a .

Page 341, line 1
delete “from the *Gramineae*”

Page 341, line 2
insert , *Gramineae* after Frake 512

Page 341, line 4
insert , *Gramineae* after Kajewski 276

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BAT CAVE REVISITED

BY

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AND JULIÁN CÁMARA-HERNÁNDEZ*

IN 1948 an expedition sponsored by the Peabody Museum of Harvard University and led by Mr. Herbert Dick, then a graduate student, uncovered many cobs and other parts of maize from the accumulated refuse in a once-inhabited rock shelter in New Mexico known as Bat Cave. These prehistoric remains were significant in several respects: (1) they were the first remains discovered which showed clearly the nature of primitive maize; (2) they provided tangible evidence of a well defined evolutionary sequence; (3) they represented the first archaeological evidence showing: (A) that primitive maize was both a popcorn and a form of pod corn, (B) that maize did not originate from teosinte, (C) that much of the variation in modern maize is the product of introgression from teosinte (Mangelsdorf and Smith, 1949).

Since the 1948 expedition had excavated only one section of the cave, Mr. Dick in 1950 made a second expedition which excavated additional sections in the hope of finding still older vegetal remains. A preliminary

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examination of the maize specimens of this second expedition showed that the earliest cobs were even more primitive in some respects than those found in the 1948 excavation and the specimens tended to confirm in general the principal conclusions drawn from the detailed study which had been made of the 1948 collection. It was our intention at that time to make a similar detailed study of the 1950 collection and to publish the results at an early date. In the meantime, however, the senior author participated in a project involving the classification and description of the living races of maize of Mexico (Wellhausen *et al.*, 1952) and this made it possible to identify precursors of several living races of maize found in archaeological excavations in northeastern Mexico by MacNeish (Mangelsdorf *et al.*, 1956) and in northwestern Mexico by Lister (Mangelsdorf and Lister, 1956). Studies of still other collections of archaeological maize had shown strikingly the importance of teosinte introgression in the evolution of maize (Galinat *et al.*, 1956). In view of these developments, it was decided to postpone the final studies of the 1950 collection of Bat Cave specimens until still other collections which had come to the Botanical Museum from various sources could be analyzed. These several studies of specimens from sites in Mexico and the United States have been completed (Galinat and Ruppe, 1961; Galinat and Gunnerson, 1963; Mangelsdorf *et al.*, 1964; Mangelsdorf *et al.*, in press). We can now re-examine the two Bat Cave collections with the benefit of a familiarity with the living races of maize, a considerably greater experience in analyzing archaeological material, and in the light of significant evidence revealed by other collections of which one of the most important is from sites in the Valley of Tehuacán in Mexico in which remains of prehistoric wild corn were found.

THE 1950 EXCAVATION

Since the Bat Cave site and its environs were described in detail in the 1949 report as well as in a more recent publication (Dick, 1965) there is no need to repeat the description here.

The 1950 expedition comprised three members all from the University of Colorado; Herbert W. Dick, who directed the excavation, Francis Olson and Allen Olson. The excavation was made from August 1 to September 6.

The main purpose of the second expedition was to obtain additional prehistoric vegetal material, especially of maize, and charcoal from all levels for radiocarbon dating. Stone and other artifacts were collected as by-products. Except for finding a new type of knotted-fiber container these proved to be similar in virtually all respects to those turned up in the 1948 excavation.

Because there was no obvious stratigraphy in the cave corresponding to cultural phases, the material was removed in arbitrary strata of 12 inches each: 0-12'', 12-24'', etc. Since three different sections of the cave were excavated and since the sterile sand representing Antevs' dry level on which the cave deposits rest, occurs at different levels in different parts of the cave, it might be supposed that arbitrary levels in one section would not correspond to those in another. In Section IB for example, the sterile sand occurs at 36'' while in IC it is found at 60''. However, the cobs in the 24-36'' level of IB are similar to those in the 24-36'' level of other sections. Consequently we have averaged the data on cobs and kernels according to the arbitrary levels in which the specimens were found. Although this procedure lacks refinement it still demonstrates an evolutionary sequence of the maize remains from the lower to the upper levels of the deposit.

Dating of the Remains

One of the most important questions to be answered is the date of the remains. The radiocarbon determinations (Libby, 1951; Arnold and Libby, 1950) of samples of charcoal and other materials from the several levels are set forth in Table I. The data from the two excavations are fairly consistent for the three uppermost levels but differ widely for the two lower levels. There is reason to believe that the date of 5605 for the charcoal in the 48-60'' level is not valid for the associated earliest maize.

TABLE I. Radiocarbon dates of charcoal, wood fragments, and cobs from the two Bat Cave excavations.

1948 Excavations			1950 Excavations		
Material	Level	Date	Material	Level	Date
cobs	0-12''	1752 $\pm$ 250			
wood	12-24''	1907 $\pm$ 250	Charcoal	11-15''	1610 $\pm$ 200
wood	24-36''	2239 $\pm$ 250	"	24-36''	2816 $\pm$ 200
cobs, wood	36-48''	2249 $\pm$ 250	"	36-48''	2048 $\pm$ 170
wood	48-60''	2862 $\pm$ 250	"	48-60''	5605 $\pm$ 290
[extrapolation]	60-66''	3000-3500	"	60-66''	5931 $\pm$ 310

On the basis of the characteristics of the cobs, especially those which represent evidence of teosinte contamination, we have concluded that the maize from the 48-60'' level of Bat Cave is later than the maize of the Abejas phase in the Tehuacán caves and earlier than that of the Ajalpan phase. This would date it at between 2300 and 1500 B.C. A similar correlation with the remains of maize in Romero's Cave, Tamaulipas, Mexico, excavated by Dr. Richard S. MacNeish (in press) makes it contemporary with the Guerrero phase dated by radiocarbon at 1800-1400 B.C. These correlations suggest that the earliest Bat Cave maize is probably not earlier than

ca 2300 B.C. and may be several centuries later.

The 1950 Bat Cave collection comprises 816 specimens and includes cobs, eroded fragments of cobs, kernels, husk systems and husk fragments, peduncles, pieces of stalk, and one tassel fragment. We shall consider these below in relation to the levels in which they were found in the Cave.

THE COBS

On the whole the cobs from this collection, numbering 444 specimens in addition to one fragment bearing kernels, were quite similar to those of the earlier excavation but with one important difference. Some of the cobs from the lowest levels were smaller and more primitive than any of those previously turned up at this site. Three of these are illustrated in Plate III, A.

Early Maize a Popcorn

The senior author and his associate, Dr. Walton C. Galinat, made an intensive study of one of these specimens which contained the partial remains of a single kernel. We spent several days in dissecting this cob and measuring all of its parts. On the basis of these measurements, Galinat prepared the diagrammatical longitudinal section illustrated in Fig. 1. We concluded that the tiny kernels which this cob must once have borne could only have been those of popcorn, a type in which the kernels are small and hard and are capable of exploding when exposed to heat. This conclusion has been amply confirmed by finding among the prehistoric grains several actual specimens of popped corn described later. The Bat Cave specimens thus provide convincing archaeological evidence in support of one part of the conclusion first reached by Sturtevant (1894) and later by Mangelsdorf and Reeves (1939) that primitive corn was both a popcorn and a pod corn.

Early Maize a Pod Corn?

Whether the earliest Bat Cave corn was also a pod corn depends upon how pod corn is defined. Geneticists know that the principal characteristics of pod corn are controlled by a single locus, *Tu*, on chromosome 4. Mangelsdorf and Reeves (1939) considered the *Tu* gene to be an ancient wild one still surviving in modern varieties but they also pointed out that the pod corn of today is not the pod corn of wild corn:

The pod corn found occasionally as a mixture in modern cultivated varieties is certainly not the wild pod corn which the wandering Indians discovered millenia ago. Modern pod corn is the result of superimposing a single 'wild' gene with perhaps a few closely linked modifiers upon a genetic complex which has been tremendously altered by centuries of domestication.

Intensive research on pod corn and its genetic locus by the senior author and his associates over a period of almost 30 years has shown that *Tu* locus is a compound

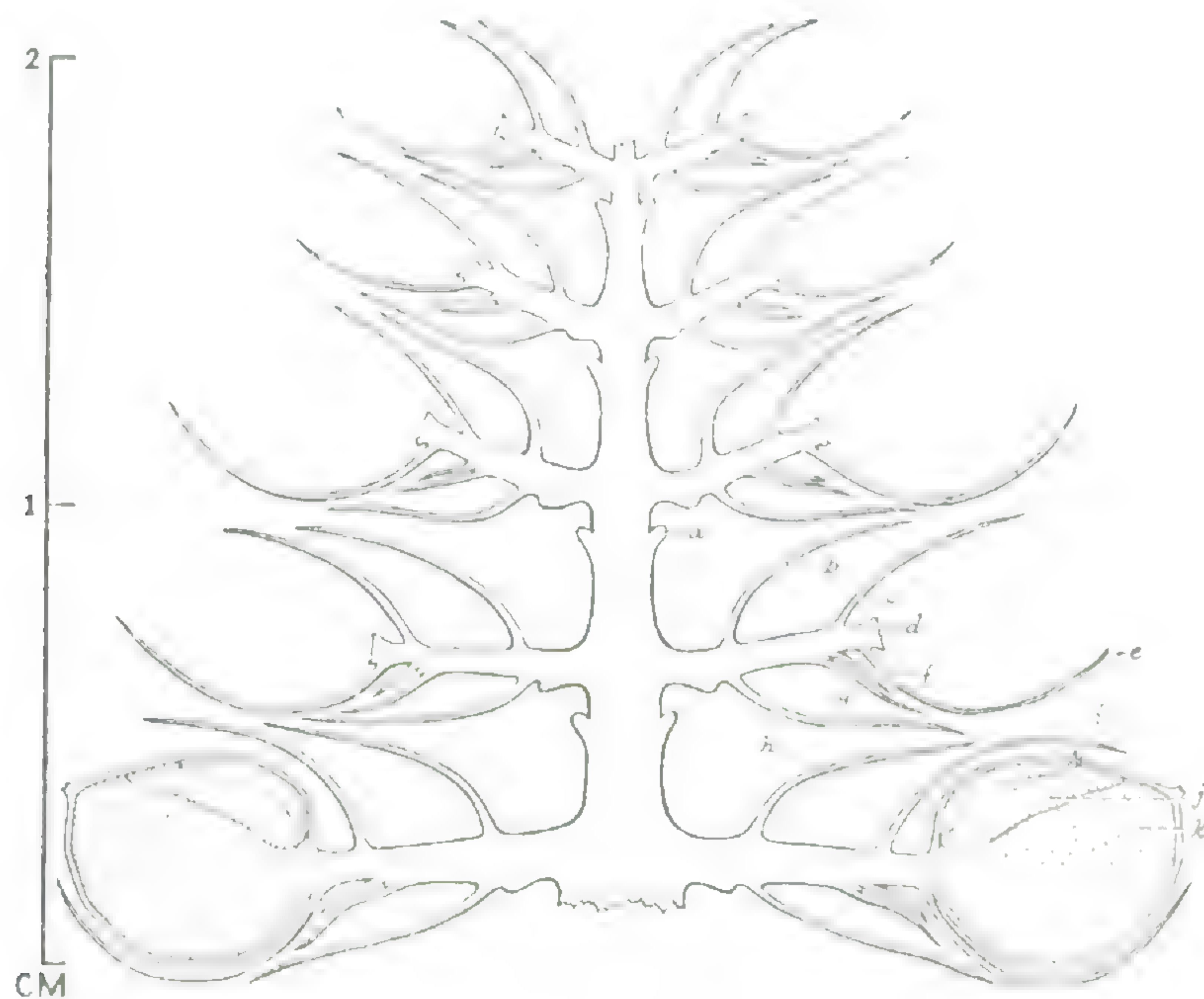


FIG. 1. Diagrammatic longitudinal section of one of the Bat Cave cobs based on measurements of dissected parts. The tiny kernels show that this was a popcorn; the long pedicels on which the kernels are borne and the bracts which almost enclose them indicate that it was also a pod corn.

Drawn by W. C. GALINAT

one having at least two components (Mangelsdorf and Galinat, 1964) and possibly three, one of which is identical in its expression with a previously recognized mutation at this locus designated as ‘half-tunicate’ because its effects are about half of those of tunicate (cf. Mangelsdorf and Reeves, 1959). We also discovered in the popcorn variety, Baby Golden, a major modifying gene which we have called tunicate inhibitor and given the symbol, *Ti*. This gene has its locus on chromosome 6 and is linked with the gene for endosperm color on that chromosome. Combinations of the several components of the *Tu-tu* locus with and without the major modifying factor *Ti* produce a spectrum of phenotypes at one end of which all of the kernels are completely enclosed in glumes and at the other all of the kernels are completely exposed in their upper surfaces but are surrounded in their lower surfaces by glumes which are longer than those of modern varieties of corn.

The earliest cobs from the Bat Cave 1950 collection are of this latter phenotype as the diagram in Fig. 1 shows. They have relatively long floral bracts, the lemmas and paleas surrounding the kernels but not completely enclosing them. In the 1950 collection we have also found one fragment of a cob containing kernels which shows exactly this condition. This is illustrated in an enlarged photograph in Plate II, C, D, and in Fig. 2.

The earliest cobs also have other characteristics of pod corn including the slender central stem, the rachis, and relatively long secondary stems, the pedicels or rachillae, upon which the kernels are borne.

There has been some skepticism with respect to our conclusion that cobs of this type represent pod corn (Randolph, 1956; Weatherwax, 1956; Goodman, 1965). Since prehistoric kernels from such cobs, even when present, have long since lost their viability there is no

way of determining their genotype. However, since we can duplicate the principal characteristics of such specimens by combining the components of the *Tu* locus on chromosome 4 with the major modifying factor *Ti* on chromosome 6 and with other modifying genes from various popcorn varieties and since neither we nor our critics have yet found any other way to duplicate these characteristics, we shall continue to regard these early

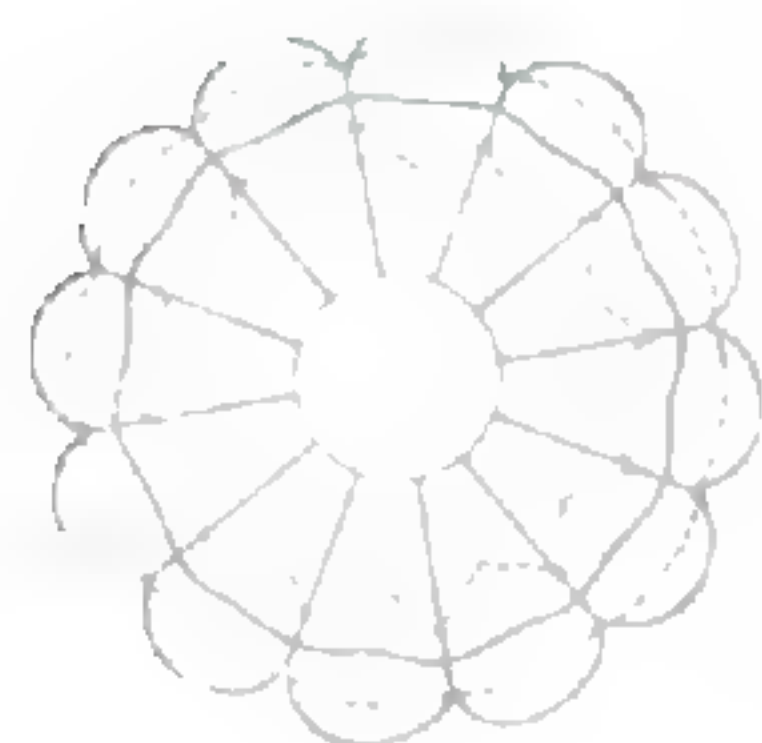


FIG. 2. Diagrammatic cross section of the early Bat Cave cob illustrated in Plate II, C and D. The slender rachis (inner circle), the long rachillae (distance between rachis and base of kernels), the long glumes (solid line), and the paleas (broken line) which almost enclose the kernels, all indicate that this is a form of pod corn.

cobs as representing a form of pod corn and we shall adhere to the conclusions of Sturtevant and of Mangelsdorf and Reeves that primitive corn was both a popcorn and a pod corn.

Changes in the Rachis Diameter

We shall, however, modify the conclusion reached in the description of the cobs from the 1948 collection in which we attributed changes in the cob/rachis ratio largely to replacement of higher alleles of the *Tu-tu* locus by lower alleles including one designated as *tu^u*. We have not in our experimental cultures been able definitely to establish the existence of such an allele or if it exists to distinguish its effects from those of various modifying factors whose role, in causing variation in the diameter of the rachis and the length of the glumes, was postulated in the 1949 paper. Changes in the cob/rachis ratio in this material now appear to be more a matter of increase in the diameter of the rachis than in the reduction in the length of the glumes. The data in Table II, based on 430 cobs in which the rachis diameter could be measured, show that there has been an increase in the

rachis diameter from 7.0 mm. to 8.9 mm. in the period represented by the remains of maize in this cave.

Increase in Variation

More conspicuous than the increase in the size of the rachis is the increase in variation of the cobs. Several of the earliest cobs from the 1950 collection resemble the prehistoric wild corn from the Tehuacán site but not all

TABLE II. Rachis diameters (mm.) and kernel-row-numbers of the cobs from successive levels of Bat Cave.

Level Inches	Rachis Diam. Av.	Kernel-row-numbers							
		No. Cobs	8	10	12	14	16	18	Av.
0-12	8.9	70	8	20	28	12	2		11.4
12-24	7.8	99	10	25	35	22	4	3	11.8
24-36	7.9	120	12	30	55	16	5	2	10.2
36-48	7.2	142	28	42	54	13	5		10.9
48-60	7.0	13	1	9	1	2			10.6
No. Cobs	430	444	59	126	173	65	16	5	

of them are of this type. The majority of them are small but there is considerable variation in their other characteristics, especially in the size and shape of cupules. There is some evidence that introgression with teosinte had already occurred in some of the cobs from the lowest level. Based on the characteristics of the cobs we conclude that the corn from the 48-60'' level in Bat Cave, as already mentioned, is later than the corn of the Abejas phase in the Tehuacán sites and earlier than that of the Ajalpan phase.

The evidence of teosinte contamination is even more clear-cut in the specimens from the 36-48'' level than in the 48-60'' level. Photographs of several specimens with indurated tissues and solitary pistillate spikelets are illustrated in Plate I, C and E.

The cobs in this and subsequent levels are so hetero-

geneous in their characteristics that it is impossible to classify all of them with respect to race. However, some of the cobs clearly resemble those of the race Chapalote. A series of these from the lower to the higher levels is shown in Plate III, B.

Another type of cob thicker and more nearly cylindrical in shape than those resembling Chapalote is illustrated in Plate IV. These may be related to the Mexican race, Blando de Sonora, described by Wellhausen *et al.*, 1952. Some of the kernels with colorless pericarp and floury endosperm illustrated in Plate III, C may also be related to this race.

Changes in Kernel-row Number

An increase in the diameter of the rachis provides a larger surface on which kernels can be borne and this results in either a higher kernel-row number or in larger kernels or in both. Table II shows that there has been a change in the kernel-row number from the lower levels to the higher. The modal number in the lowest level is 10 and in all higher levels, 12. The average row number of the cobs from successive levels, the lowest to the upper, is 10.6, 10.9, 10.2, 11.8, and 11.4. The increase in kernel-row number has, however, been relatively smaller than the increase in kernel size discussed below.

THE KERNELS

Increase in Size

There are 299 well preserved kernels in this collection, a much larger number than found in the 1948 material. The data in Table III show that there is a substantial increase in kernel length and width from the lower levels to the higher accompanied, however, by a decrease in thickness. The kernels from the lowest level are almost isodiametrical in their dimensions; kernels from upper levels tend to be longer, wider, and flatter.

TABLE III. Dimensions of kernels of different pericarp and aleurone colors from successive levels of Bat Cave.

Cave Level Inches	Number of Kernels and their Length, Width and Thickness in mm.															
	Brown				Red				Variegated				Colorless			
	No.	L	W	T	No.	L	W	T	No.	L	W	T	No.	L	W	T
0-12	7	7.5	7.3	5.5	1	7.4	11.3	6.9					10	8.2	8.6	5.4
12-24	44	6.9	6.8	5.4	10	7.6	7.1	5.3	4	8.0	7.8	5.3	74	7.8	8.1	5.6
24-36	16	6.7	6.7	5.5									3	8.0	7.8	5.6
36-48	29*	6.9	6.7	5.7	26	7.3	6.8	5.3	9	7.2	7.3	5.5	37	7.1	6.7	5.5
48-60	10	6.8	6.7	5.8	1	7.7	6.5	5.3								

* Ten additional brown kernels employed in a popping experiment are not included in these measurements.

Changes in Pericarp Color

The majority of the kernels are so well preserved that it is possible to classify them with respect to pericarp color. Of the 293 kernels so classified: 116 are brown, 38 red, 13 variegated, 2 with colored aleurone, and 124 with colorless pericarp and aleurone.

The kernels with brown pericarp are more frequent in the lower levels than in the higher and they are smaller on the average than the kernels with red or colorless pericarp. The fact that the kernels from the lower levels of Bat Cave are predominantly brown suggests that this is the primitive or "wild" color. Also most of the early prehistoric corn in South America has brown pericarp color as do the kernels of corn's relative, teosinte and *Tripsacum*.

Pericarp color in maize is the product of the interaction of genes at two, in some cases three, different loci. Brown pericarp results when the *P* factor on chromosome 1 interacts with one of the several alleles at the *A* locus on chromosome 3: A^{b_1} , a^{p_1} , and a_1 . Since the kernels from the lower levels are predominantly brown and since the a_1 allele is not common in maize, it seems probable that the genotype of the early kernels is $A^{b_1}A^{b_1}PP$. The red kernels probably represent mutations to A_1 , perhaps resulting from the introgression of teosinte which is known to have mutagenic effects (Mangelsdorf, 1958).

Variegated Pericarp. Thirteen of the 299 kernels had variegated pericarp. This variegation is the product of a mutation system which has been intensively studied by Brink and his associates and which involves the interaction of genes at the *P* locus on chromosome 1 with a genetic factor designated as "modulator" which may occupy various positions on chromosome 1 or on other chromosomes. The fact that nine of the 13 variegated

kernels occur in the 36-48'' level indicates that a mutation system similar to that studied by Brink was already in existence at an early date and the fact that the variegated kernels are larger than either the brown or red kernels suggests that the modulator system may have caused or been accompanied by other mutations involving increases in size.

Colorless Pericarp. The kernels with colorless pericarp are generally larger than those with colored pericarp and are predominantly floury. They may belong to the race, Blando de Sonora, described by Wellhausen *et al.*, 1952. We have already suggested that certain cobs may belong to this race.

Popped Kernels

In addition to the 293 kernels classified with respect to color there were six popped or partially popped kernels in which the color could not be determined with certainty but which appeared to have brown pericarp. One of these is illustrated in Plate III, D. We were able by a simple experiment to demonstrate that the early Bat Cave kernels were capable of popping. To increase their moisture content, we placed ten of the smaller brown kernels from the 36-48'' level in a petri dish with a piece of moist paper towel for 48 hours. When dropped into hot oil all of these popped in varying degrees. One of these, a popped-prehistoric kernel, is illustrated in Plate III, D where it is compared with a prehistoric-popped kernel from the same level.

PEDUNCLES

Twenty-one specimens of peduncles or "shanks" were found in this collection. Those from the lower levels were usually more slender than those from the higher levels as is shown by the specimens illustrated in Plate

V. Part of the increase in size may be the result of clusters of small ears being replaced by single large ears as discussed below.

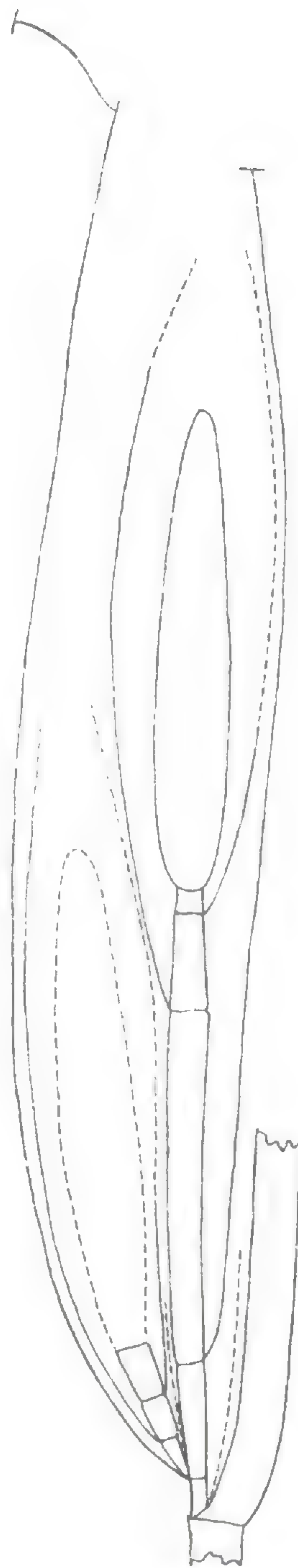
HUSKS

The most important modification of a conclusion based on the 1948 collections, which resulted from a study of the 1950 specimens, is concerned with the nature of the husks. There were three husk systems and 47 husk fragments. In the 1948 collection we found in Stratum II a long husk which shows no evidence of ever having been shaped around an ear. Furthermore its peduncle as well as the peduncle of the ear which it once bore are both quite slender. A cob which might have been enclosed in this husk system was illustrated in Plate XXVII of the 1949 report. Because this cob is much shorter than the husks, we reached what we then considered an "almost inescapable conclusion" that husks at this stage in the evolution of maize did not tightly enclose the ear but instead were involucre of leaf sheaths, not greatly modified, surrounding the base of the pistillate inflorescence but not completely enclosing it. "Inescapable conclusions" sometimes turn out, when additional evidence is forthcoming, to require modification. The additional evidence from the 1950 collections suggests that a long husk of this type enclosed not a single ear but a cluster of ears. This evidence comes from two specimens: one husk system (Plate V, B) in which the husks are only slightly longer than the 1949 cob which is illustrated in Plate VI, B and the other a piece of stalk with an attached slender peduncle bearing at the base the scar of a branch (Plate VI, D). Considering all of these specimens together we now reach the conclusion that the long husk probably enclosed a cluster of at least two ears, each of which had its own husks which were only slightly longer than the ears. The situation is illustrated in the

diagram in Fig. 3. The specimens on which it is based are illustrated in Plate VI.

That this conclusion may be more nearly correct than the earlier one is supported by the fact that in our genetically reconstructed wild corn produced by combining components of the tunicate locus with genes from various popcorn varieties, we have encountered exactly this situation: clusters of small ears each enclosed in short husks and the entire cluster enclosed in long husks which flare open at maturity.

FIG. 3. Diagrammatic longitudinal section based on specimens illustrated in Plate VI showing how the long husks may have enclosed a cluster of short ears, each enclosed in its own husks. Solid lines represent actual specimens; broken lines indicate what may have been the additional parts.



TASSELS

Only one specimen of tassel, a fragment of a central spike, was found and this occurred in the uppermost level. Its spikelets have relatively long glumes. Since the specimens of tassels found in the 1948 excavation, although described, have not been illustrated, we are

including a photograph of them in Plate VII. The spikelets on most of the fragments are smaller and more delicate than those of the majority of modern varieties but in other respects are similar.

CONCLUSIONS

1. The earliest maize from the second (1950) Bat Cave expedition is more primitive than any of the specimens turned up in the first (1948) expedition.

2. Maize from the lower levels of the cave is definitely a popcorn. There are several popped kernels among the prehistoric remains and other prehistoric kernels proved to be still capable of popping after having their moisture content raised.

3. The earliest maize is probably a form of pod corn. At least it has relatively long soft glumes partly enclosing the kernels which are borne on long rachillae. These are characteristics of pod corn.

4. The maize from the lowest levels has brown pericarp color and is related to the Mexican race, Chapalote. Brown pericarp color is presumably the primitive or "wild" color. Brown pericarp is less frequent than red and colorless pericarp combined in the upper levels of the cave.

5. The occurrence of variegated pericarp in the 36-48'' level shows that a mutation system similar to that involving the "modulator" factor was in existence at an early stage in corn's domestication.

6. Clear-cut evidence of the introgression of teosinte or *Tripsacum* or both appears in the 36-48'' level of the cave and there is some evidence of introgression in the earlier 48-60'' level.

7. There is an increase in diameter of the rachis of the cobs from the lower to the upper levels; this is accompanied by an increase in kernel-row number and in the length and width of the kernels. There is a slight decrease in kernel thickness.

8. The remains of the husks and other parts of the husk systems suggest that the long husks found in one of the levels of the 1948 excavations enclosed not a single ear but a cluster of ears each enclosed in its own husk.

9. Comparisons with the prehistoric maize of other sites suggest that the earliest maize from Bat Cave should be dated at not earlier than 2300 B.C. and perhaps several centuries later.

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PLATE I. A and B. Two views of a segment of a disarticulating "tripsacoid" cob from the 24-36" level. The pedicellate member of each pair of spikelets is staminate. The kernels have brown pericarp and are almost completely enclosed by the glumes. With respect to the pistillate spikelets, this is a four-rowed ear. C. Tripsacoid cob from the 36-48" level showing highly indurated tissues of the rachis. Approximately half of the pistillate spikelets are solitary. D. This specimen appears to be the pistillate basal part of a tassel branch or an unbranched tassel. E. A tripsacoid cob from the 36-48" level showing highly indurated tissues of the rachis, a whorled phyllotaxy, and a solitary spikelet. F. Fragment of a cob from the 36-48" level showing the almost square shaped cupules which are similar to those of the prehistoric wild corn from Tehuacán Valley. All photos $\times 3.7$.

PLATE I

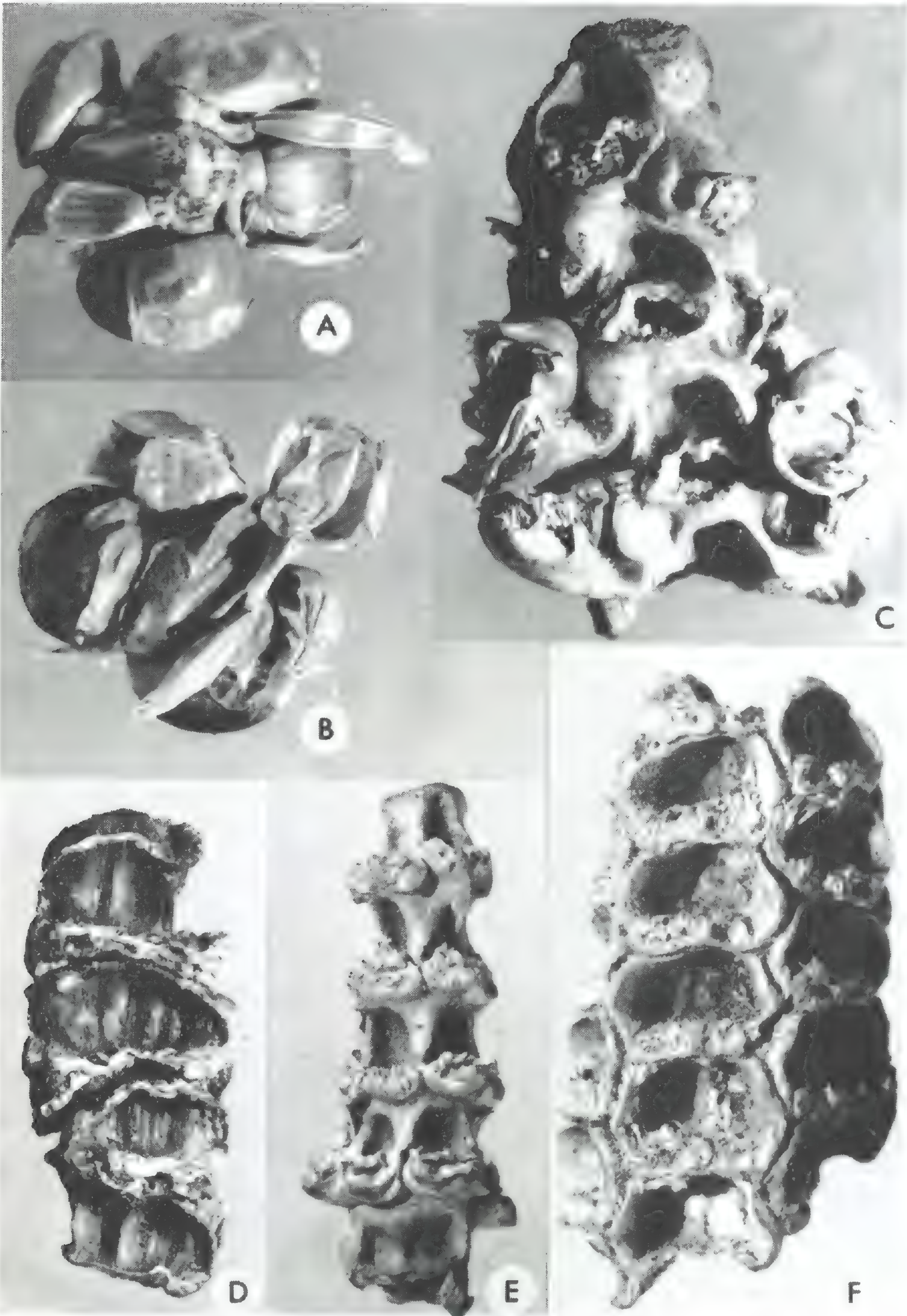


PLATE II. A. A well preserved cob from the 48–60'' level showing relatively long, soft lower and upper glumes and one cupule with a spikelet removed illustrating prominent cupule rims. This cob appears to be that of a form of pod corn. B. Fragment of an eroded cob from the 36–48'' level showing a tendency for adjacent cupules to fuse and their rims to disappear. C and D. Two views of a fragment of an ear from the 36–48'' level showing (1) the slender rachis and the long lower glumes and paleas and (2) the small round kernels with brown pericarp partially surrounded by the glumes and other floral bracts. All photos $\times 3.7$.

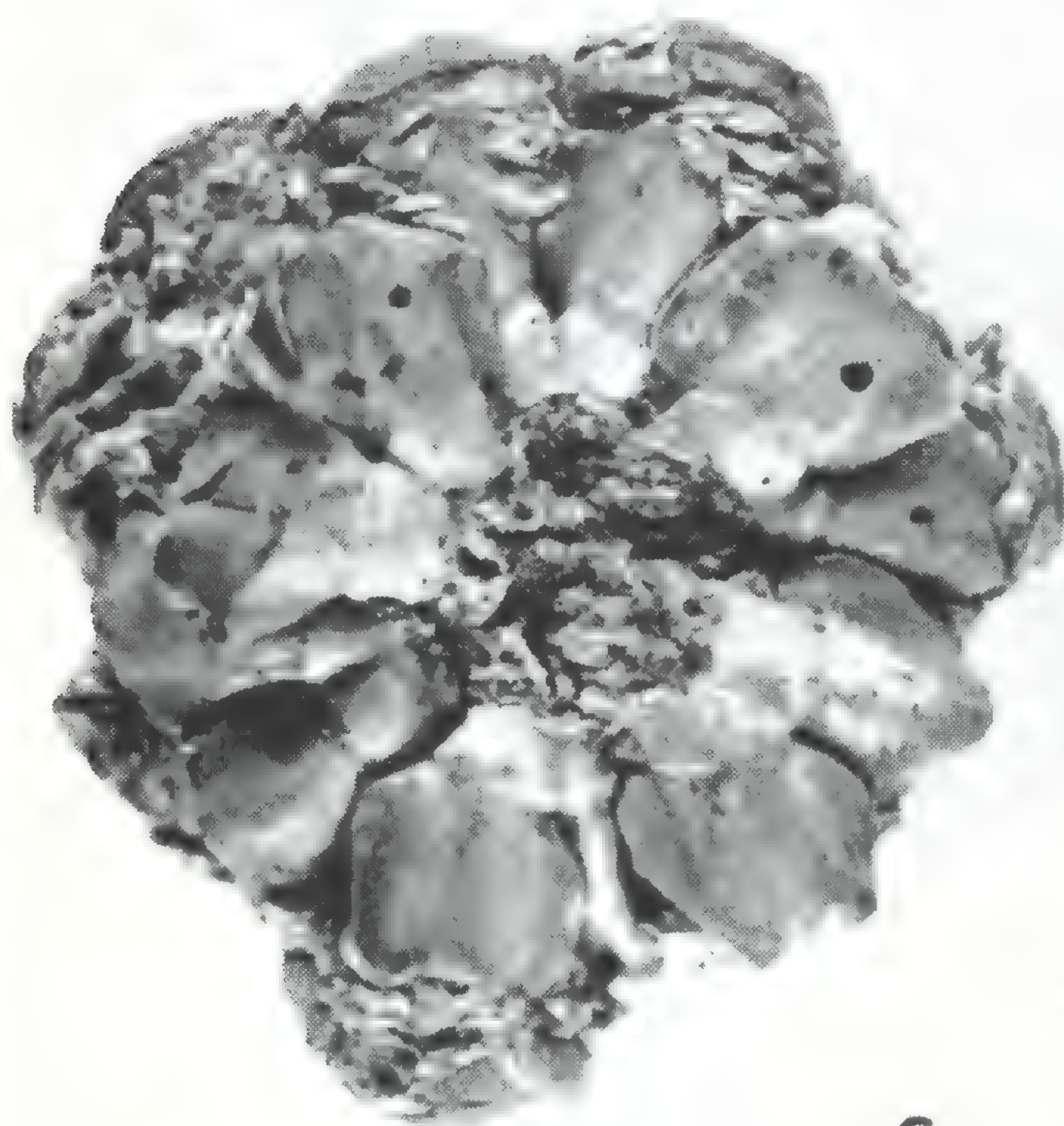
PLATE II



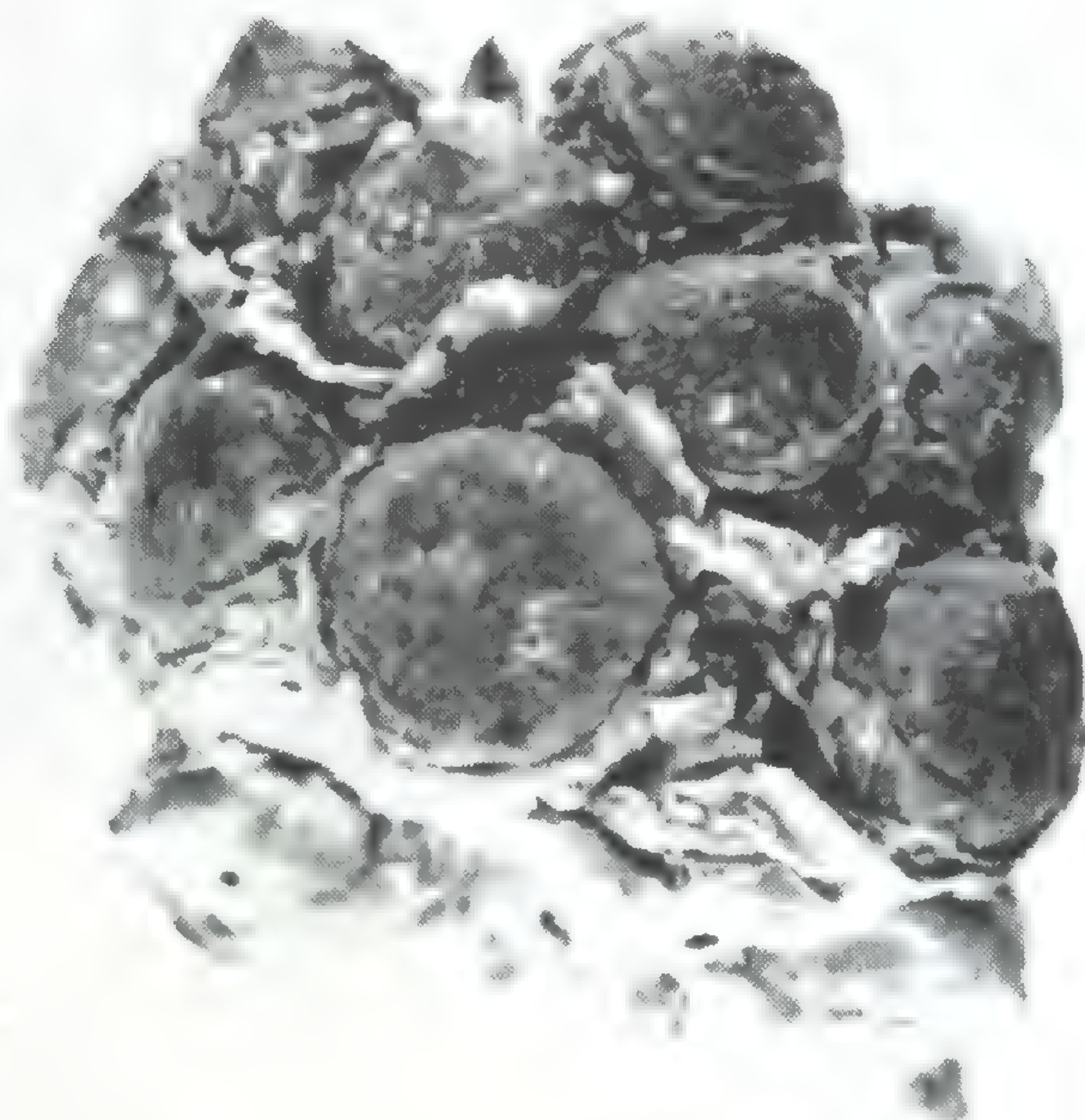
A



B



C



D

PLATE III. A. Three cobs from the lowest level of the 1950 excavation. The diagrammatic longitudinal section illustrated in Fig. 1 is based on one of these. B. An evolutionary series of Chapalote-type cobs, the shortest from the 48-60'' level, the longest from the 12-24'' level. C. Typical kernels with brown (left), red (center), and colorless pericarp. D. A prehistoric popped kernel from the 36-48'' level compared with a popped kernel produced by exposing a prehistoric kernel from the same level to heat. All photos actual size.

PLATE III

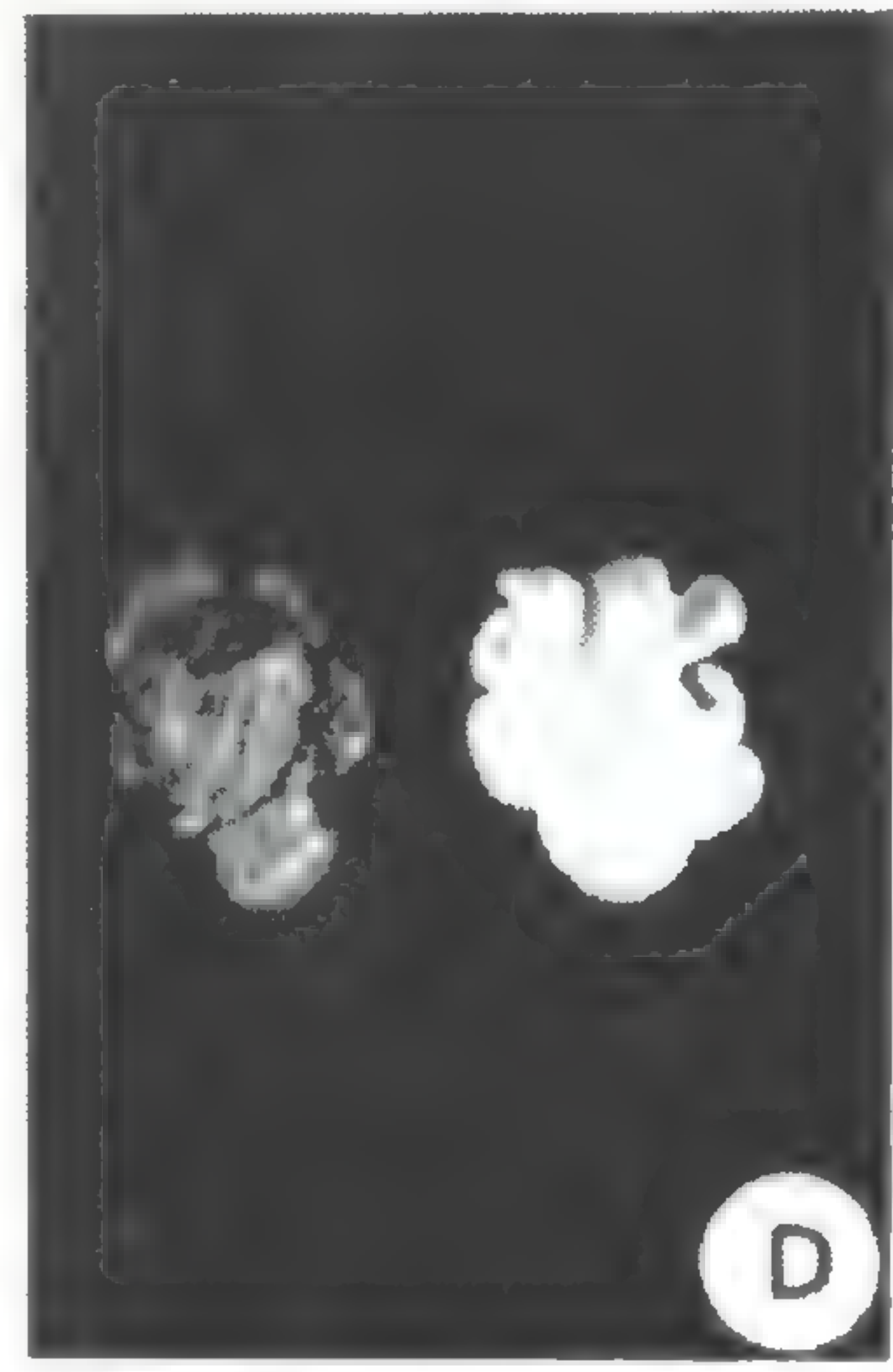
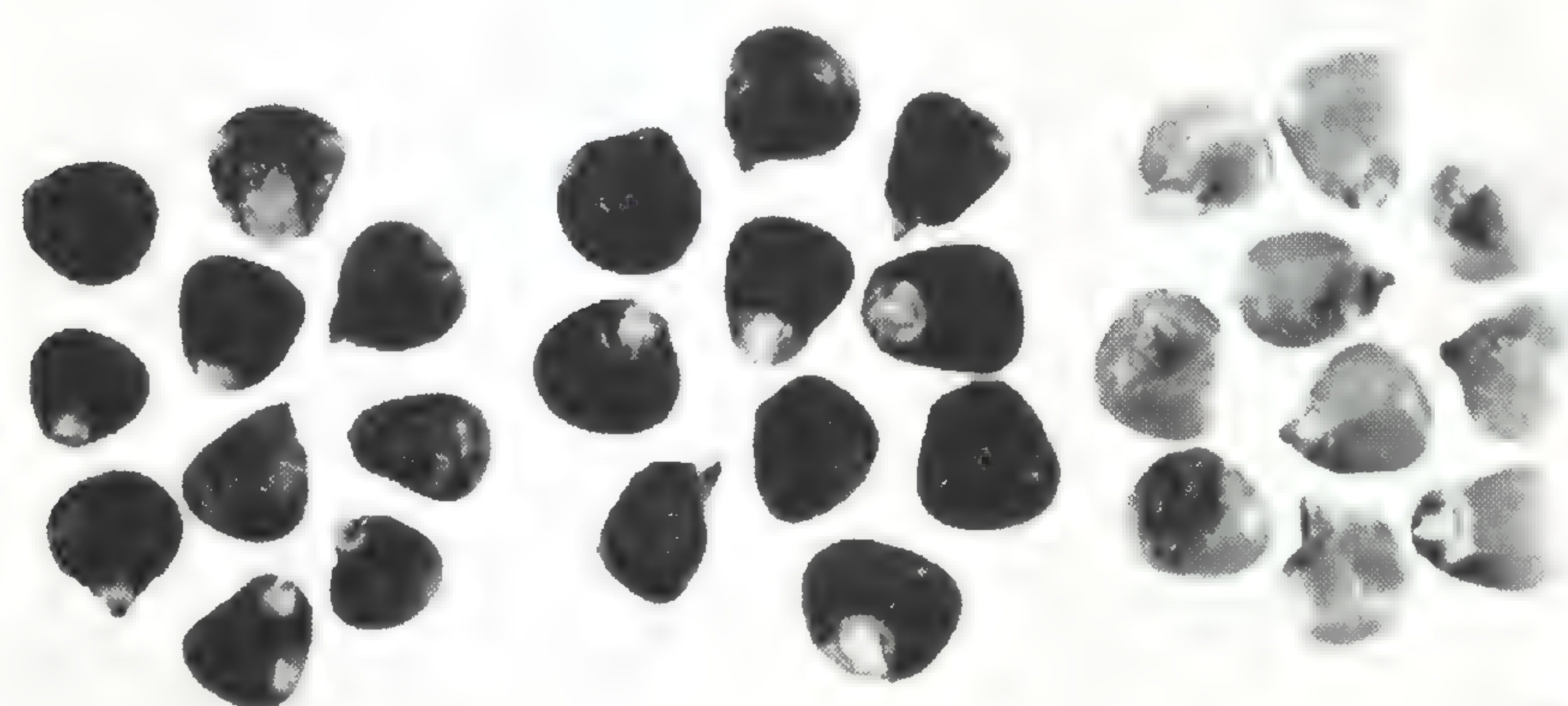
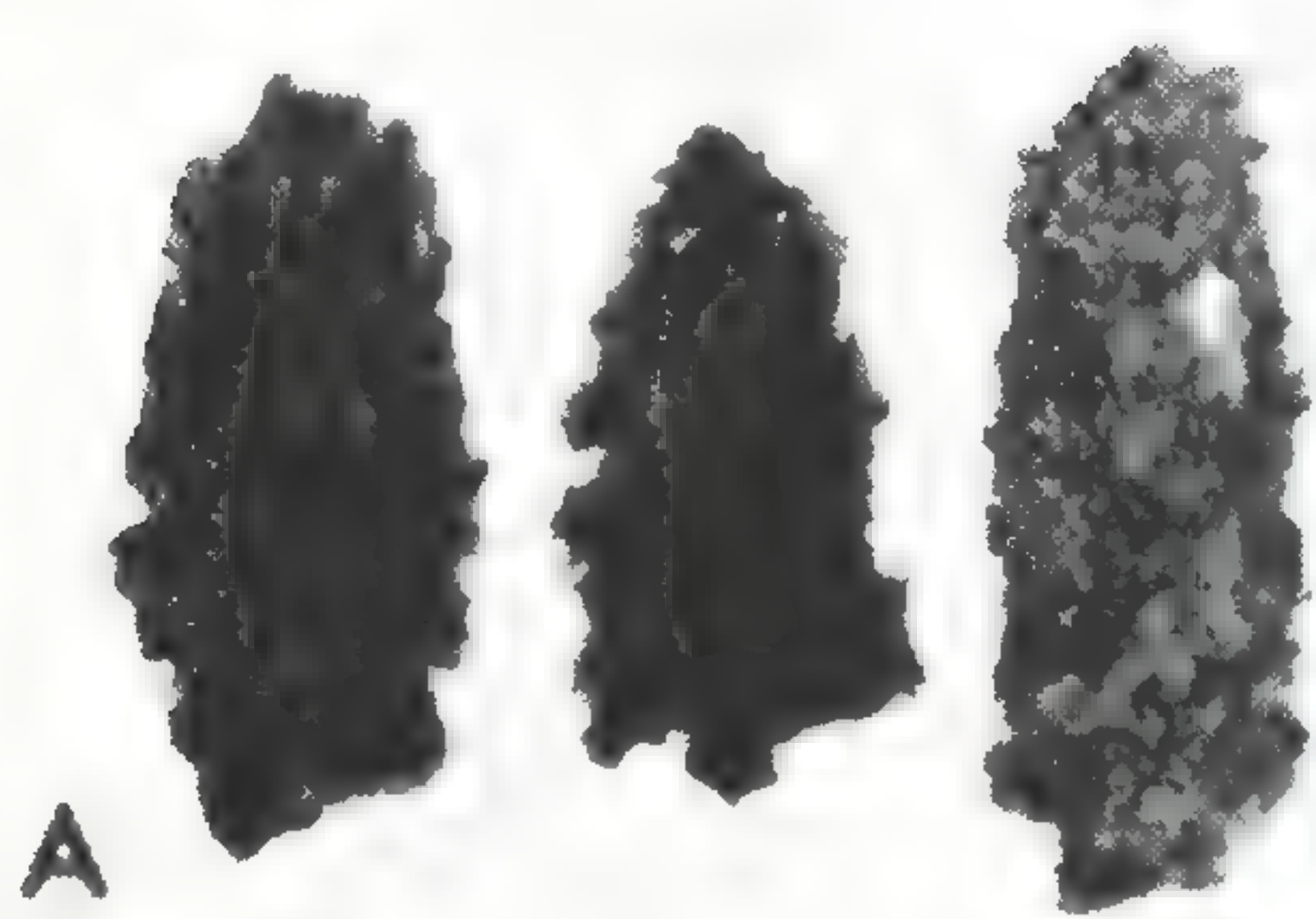
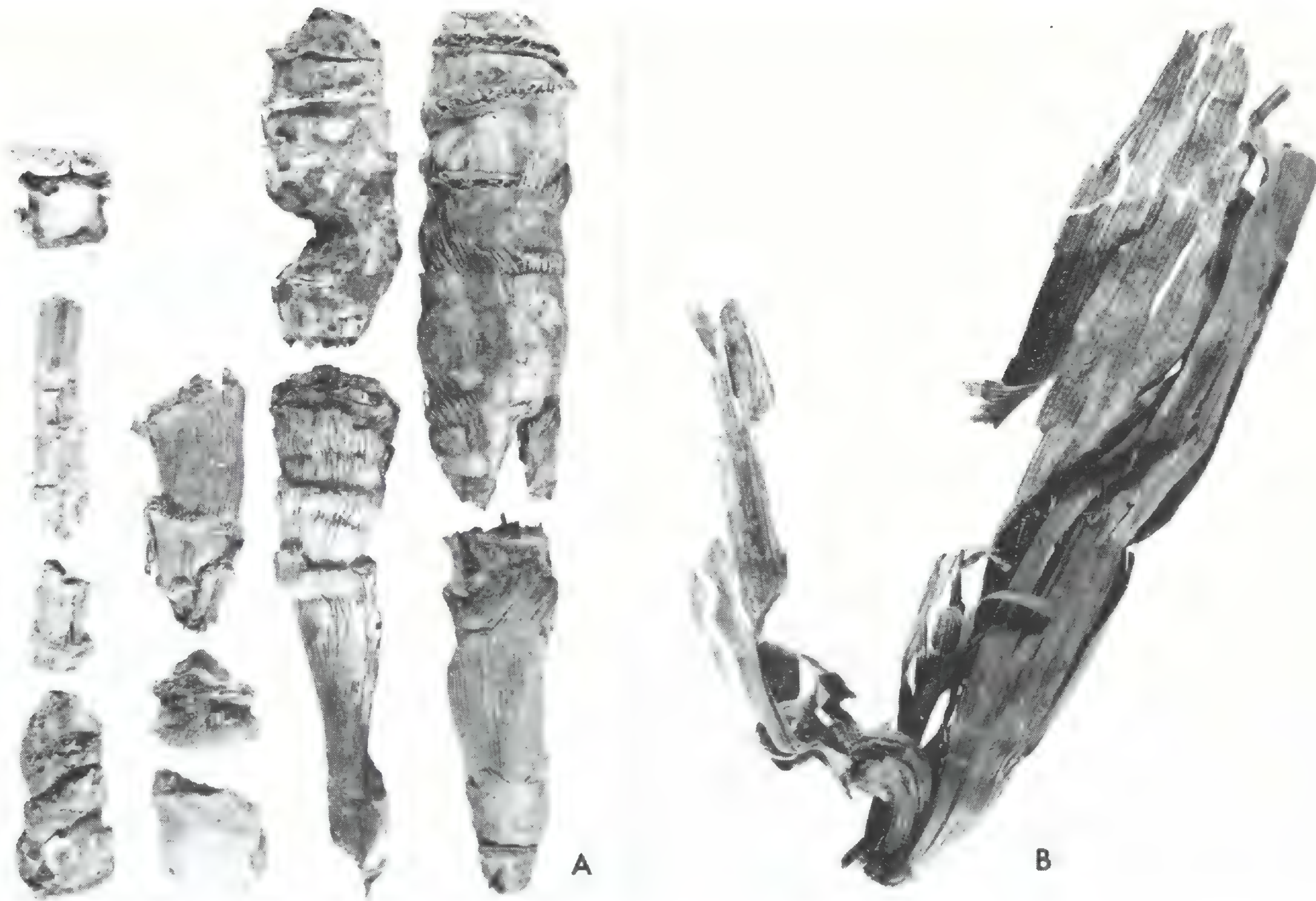


PLATE IV



Typical cobs related to the Mexican race, Blando de Sonora from the 23-36'' levels.



A. Specimens of peduncles arranged in sequence from the lower to the upper levels. The vertical rows represent the 36-48'', 24-36'', 12-24'', 0-12'' levels respectively. B. Remains of husk system from the 36-48'' level. Actual size.

PLATE VI. A. A long husk from level II of the 1948 excavation. B. A Chapalote-type cob from the 1948 collection. C. A husk from the 36-48'' level which might have enclosed an ear of about the size represented by the cob in B. D. Piece of a stalk from the 36-48'' level with peduncle of an ear arising from it. At its base the peduncle has the scar of a branch. E. A slender peduncle of about the diameter of the branch once attached to the base of D. These specimens are combined in a diagrammatic longitudinal section in Fig. 3. Three fourths actual size.

PLATE VI



PLATE VII



Fragments of tassel branches from the 1948 excavations. The vertical rows from left to right represent levels VI, V, IV, IV, IV respectively.

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PREHISTORIC MAIZE, TEOSINTE, AND TRIPSACUM FROM TAMAULIPAS, MEXICO

BY

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IN an earlier paper (Mangelsdorf *et al.*, 1956) we described the prehistoric maize uncovered in archaeological excavations conducted by MacNeish in 1949 in La Perra Cave in the state of Tamaulipas, northeastern Mexico. The earliest of this maize, dated at 2500 B.C. by radio-carbon determinations of associated wood and leaves, was identified as a precursor of a still existing Mexican race Nal-Tel, one of the four Mexican races described by Wellhausen *et al.* (1952) as Ancient Indigenous. We did not regard this maize, although primitive in some characteristics, as wild corn.

While excavating La Perra Cave, which is located in eastern Tamaulipas, MacNeish also made some preliminary soundings in several caves in southwestern Tamaulipas which persuaded him that still earlier corn, perhaps even prehistoric wild corn, might be found in the lower levels of the refuse of these caves. Accordingly in 1954,

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with the assistance of David Kelley, then a graduate student in anthropology at Harvard, he excavated two caves, Romero's and Valenzuela's, and sampled the refuse in a third, Ojo de Agua, all located in Infiernillo Canyon. The earliest corn from these caves proved disappointingly to be not earlier than the La Perra Cave but slightly later, 2300-1800 B.C. It was, however, of a race different from the La Perra corn and showed some resemblance to the early prehistoric corn of Bat Cave in New Mexico described by Mangelsdorf and Smith (1949). We now recognize both as being related to the prehistoric wild corn of Tehuacán Valley described by Mangelsdorf *et al.* (1964).

Of even greater interest was the discovery in the Infiernillo Canyon caves of several specimens each of teosinte, the closest relative of maize, and of *Tripsacum*, a more distant relative. The prehistoric remains of these three species of the American *Maydeae* are described below, following a brief description of the site and its environs.

DESCRIPTION OF THE SITE

The Canyon Infiernillo is located in southwest Tamaulipas in the northern part of the municipio Ocampo. In terms of our previous investigations in Sierra de Tamaulipas (MacNeish, 1958; Mangelsdorf *et al.*, 1956), this region is about 75 miles to the southwest and has a very different environment. Immediately southwest of the dry Sierra de Tamaulipas at an elevation never over 1500 feet is the wide flat meandering Guayalejo River Valley with a tropical vegetation extending up from the south. West and southwest of this valley lie the first north-south oriented ridges of the Sierra Madre mountains. The lower slopes of these mountains are covered with a tropical, deciduous forest; from 2500 to 4000 feet the vegetation forms a cloud forest; and at higher eleva-

tions a pine-oak forest occurs. Further to the west the valley becomes narrow and the ridges even higher. Covered with pine-oak forests at their summits, these ridges cast "rain shadows" on the bottoms of the valleys which consequently are quite dry and have a xerophytic vegetation in which maguey, cactus, mesquite, and chaparral predominate. Canyon Infiernillo, to which we were guided in 1954 by Don Ignacio Guerra, is one of those dry canyons containing three caves named Romero's, Valenzuela's, and Ojo de Agua. These are all situated high above the canyon floor at the base of limestone cliffs and may have been the mouths of former underground rivers that have since become dry and in part filled in. These relatively deep tunnel-like caves are extremely dry and in prehistoric times would have been ideal places for living. Because of their dryness much of the refuse and remains of the ancient inhabitants has been almost perfectly preserved.

The Stratigraphy

All three caves had stratified occupational layers which not only revealed a long cultural sequence but also yielded many botanical specimens which could be brought to bear upon the problems of early agriculture and subsistence activities.

Radiocarbon determinations and correlations of artifacts with those of other sites permit us to recognize six more or less distinct cultural phases beginning at about 2350 B.C. The characteristics of these phases have been described in detail elsewhere (MacNeish, 1958). Here we need be concerned only with their approximate ages. In sequence beginning with the most recent they are:

San Antonio	A.D. 1450-1800
San Lorenzo	A.D. 1050-1450
Palmillas	A.D. 200-800

Mesa de Guaje	1200–400 B.C.
Guerra	1850–1200 B.C.
Flacco	2350–1850 B.C.

The Specimens

The maize specimens from only one of the three caves, Romero's, have been analyzed in detail but an early cob from the Flacco phase of Valenzuela's Cave has been included in the analysis as well as several specimens of teosinte and *Tripsacum*.

The collection of prehistoric remains of maize and its relatives described here comprises 12,014 specimens and includes virtually all parts of the plant: pieces of stalk, leaves, husks, cobs and cob fragments, tassel and tassel branches. There are a large number of quids of chewed stalks, young ears, and tassels as well as several specimens of teosinte and *Tripsacum*. A brief description of the remains in the several categories follows.

CLASSIFICATION OF THE COBS

All of the intact cobs as well as those almost intact were classified on the basis of their resemblance to the existing races of corn in Mexico described by Wellhausen *et al.* (1952). Nine different races or subraces were identified among the prehistoric cobs. Their relative frequency in terms of percentage of total cobs in the several levels of the cave is shown in Table I.

The Chapalote Complex

The great majority of the cobs, about two thirds of the total, were identified as belonging to the race Chapalote or its precursors or derivatives. This race is found today only in western Mexico (Wellhausen *et al.*, 1952) but it was once much more widespread. The prehistoric wild corn uncovered in caves in the valley of Tehuacán

TABLE I. Classification of the Prehistoric Specimens of Maize and Its Relatives Associated with Six Cultural Phases in Caves in Southwestern Tamaulipas.

Classification of Specimens	Cultural Phase						Total Specimens
	San Antonio A.D. 1450-1800	San Lorenzo A.D. 1050-1450	Palmillas A.D. 200-800	Mesa de Gauje 1200-400 B.C.	Guerra 1850-1200 B.C.	Flacco 2350-1850 B.C.	
Cobs							
Pre-Chapalote				2	14	1	17
Early Chapalote	5	2	24	56	46		133
Tripsacoid Chapalote	299	356	457	307	127		1546
Chapalote	108	122	116	25			371
Breve de Padilla	350	279	188	19			836
Palomero Jalisciense	7	15	11	4			37
Harinoso de Ocho	19	10	3				32
Nal-Tel	23	17					40
Tuxpeño		3					3
Unidentified Fragments	229	71	49	53	55		457
Other Maize Parts							
Stalks	13	12	5	11	6		47
Leaves	4	2	2		1		9
Husks	45	60	70	42	2		219
Tassels	6869	904	307	15	4		8099
Quids	44	39	63	5			151
Maize Relatives							
Teosinte			1	7	1		9
Maize-teosinte Hybrids				1	2		3
Tripsacum		1	1		2	1	5
Total Specimens							12,014

in southern Mexico is related to Chapalote (Mangelsdorf *et al.*, 1964) as is also the earliest prehistoric corn from Swallow Cave in Sonora, Mexico (Mangelsdorf and Lister, 1956) and from Bat Cave in New Mexico (Mangelsdorf *et al.*, 1967). Ears, kernels, and cobs of this race have also been identified among the prehistoric specimens from archaeological sites in Arizona, Utah, Colorado, Nebraska, Oklahoma, and Texas. This race, originating from its wild progenitor in southern Mexico, spread through western and northwestern Mexico and from there throughout the region now the southwestern United States. It has not been found, however, either archaeologically or among existing races, in lowland eastern Mexico. There the earliest corn is Nal-Tel, a race closely related to Chapalote and perhaps stemming from it. Nal-Tel is found today in Yucatan and Campeche and sporadically in Oaxaca and Guerrero. One collection of this race has been made in San Luis Potosi (Wellhausen *et al.*, 1952). The chief difference between these two ancient races is in pericarp color, Chapalote having brown and Nal-Tel orange pericarp. Other differences include shape of the ear and hairiness of the cupules. Although the differences are not consistent, Chapalote tends to have a longer, more tapering, cob than Nal-Tel and to have cupules which are less hairy.

The fact that Chapalote is the predominating race in the prehistoric cobs from Canyon Infiernillo caves while the early corn from La Perra Cave is exclusively Nal-Tel (Mangelsdorf *et al.*, 1956) suggests that races of cultivated maize, like other artifacts, are characteristic of the cultures to which they belong. The people who occupied La Perra Cave were evidently related to lowland agriculturists of eastern Mexico while those of the Canyon Infiernillo caves had their affinities westward and northward (MacNeish, 1958). It would also appear that races

of maize, although clearly related to each other such as Chapalote and Nal-Tel, had early become adapted to different highland and lowland environments and tended to spread within these "ecological zones." This in turn suggests that perhaps it was only at the latest prehistoric levels that the culture and agriculture of the highlands and lowlands merged to become the single "culture area" Meso-America.

Pre-Chapalote. (Plate VIII, A). Following the nomenclature employed in our earlier descriptions of prehistoric maize (Mangelsdorf *et al.*, 1956; Mangelsdorf and Lister, 1956) we have called the earliest corn uncovered in Romero's Cave Pre-Chapalote. The cobs of this subrace have the same tapering shape as those of the modern Chapalote but are much smaller. None are as small, however, as the prehistoric wild corn from Tehuacán Valley. We assume that even the earliest corn from the Tamaulipas caves is cultivated corn.

Pre-Chapalote makes its first appearance (a single cob) in the Flacco phase of Valenzuela's Cave dated at 2350–1850 B.C. It appears last in the Mesa de Guaje phase dated at 1200–400 B.C. The total number of cobs of this subrace is 17.

Early Chapalote. (Plate VIII, A). The cobs of this subrace, comprising 133 specimens, are intermediate in size between those of Pre-Chapalote and modern Chapalote. In other respects the cobs are quite similar to those of modern Chapalote. Cobs of this subrace appeared first in the Guerra phase dated at 1850–1200 B.C. and last in the San Lorenzo phase, A.D. 1050–1450.

Tripsacoid Chapalote. (Plate XI, A). Slightly more than half of all identified cobs, 1546 specimens, were assigned to a subrace which we called Tripsacoid Chapalote. The cobs are quite similar to those of Chapalote but differ in the induration of their tissues, especially of

the rachises and glumes which are highly indurated. Cobs of this race are probably the product of hybridization of Chapalote with corn's closest relative, teosinte. Specimens of teosinte and corn-teosinte hybrids were found among the prehistoric vegetal remains.

The Tripsacoid Chapalote appeared first in the Guerra phase but at a later level than the Early Chapalote. A single cob occurred in level 5 and the subrace was well established (126 cobs) in level 4b which represents the end of the Guerra phase probably about 1500-1200 B.C. This corn became the predominating type in the two succeeding phases, 1200 B.C.-A.D. 800, and thereafter was gradually replaced by other races, persisting, however, as a prominent component in the complex until A.D. 1800, after the arrival of the Spaniards.

Chapalote. (Plate VIII, B). Cobs of a type quite similar to those of modern Chapalote appeared first in the Mesa de Guaje phase, 1200-400 B.C. They increased in frequency in the Palmillas phase (14.5 percent of all cobs) and continued to maintain approximately this frequency until the end of the series. A total of 361 cobs were assigned to this category.

Wellhausen *et al.* (1952) collected modern Chapalote in only two states in Mexico, Sinaloa and Sonora, but as pointed out above it must at one time have been much more widespread.

Breve de Padilla. (Plate X, A). Making its first appearance only slightly later than modern Chapalote—level 4a of the Mesa de Guaje phase—is a race called Breve de Padilla by Wellhausen (unpublished).

The origin of this race is not definitely known. Its cobs are longer and thicker than those of Chapalote and it may be the product of hybridization between Chapalote and Harinoso de Ocho, a race originally from South America and still found sporadically in western Mexico.

Not altogether consistent with this suggestion is the fact that Breve de Padilla, the suspected hybrid, appears before Harinoso de Ocho, the putative parent. However, the former occurs first in the upper level of the Mesa de Guaje phase, the latter in the lower level of Palmillas, the succeeding phase. Also, the Harinoso de Ocho had so low a frequency at all levels that its absence in the Mesa de Guaje phase may represent nothing more than a sampling error.

Whatever its origin, Breve de Padilla appears to have been a productive race which rapidly replaced other races. Starting with an initial frequency of 4.6 percent, the cobs of this race increased in succeeding phases to 23.5, 35.1, and 43.1 percent. In the San Antonio phase, A.D. 1450–1800, this was the predominating race. Altogether 836 cobs were assigned to this race.

Cobs identified as those of Breve de Padilla had previously been found among the later prehistoric specimens uncovered in the Sierra de Tamaulipas caves (Mangelsdorf *et al.*, 1956; MacNeish, 1958) but their frequency was low. This may be regarded as a further bit of evidence that this race is western in origin and that La Perra and Canyon Infiernillo caves represent different peoples with respect to their agriculture.

Minor Races

A total of 112 cobs were found which could not be assigned to any of the races described above but all seemed to be related to others of the existing races described by Wellhausen *et al.* (1952). The following races were identified among the cobs.

Harinoso de Ocho. (Plate XI, B). As already mentioned Harinoso de Ocho first appeared in the lower level of the Palmillas phase, A.D. 200–850. At no time, however, did it attain a high frequency and the total num-

ber of cobs assigned to this race was only 32, about one percent of the total identified cobs.

Although not common in Mexico today, Harinoso is important as one of the progenitors of a number of races. According to Wellhausen *et al.* (1952) Harinoso de Ocho has given rise directly to the widely grown race Tabloncillo and indirectly to Jala, Bolita, Celaya, and Cónico Norteño and is also related to Olotillo of southwestern Mexico. Evidence presented by Galinat and Gunnerson (1963) indicates that Harinoso de Ocho is the progenitor of the eight-rowed flour corn of the upper Mississippi and the eight-rowed flint corn of New England. This in turn makes it one of the ancestors of Corn Belt dent corn of the United States. It may also be, as suggested above, one of the progenitors of Breve de Padilla which became the predominating race of Romero's Cave between A.D. 1450-1800.

Nal-Tel. (Plate X, B). A total of 40 cobs were assigned to the race Nal-Tel which is the eastern lowland counterpart of Chapalote and was the predominating race in La Perra Cave in eastern Tamaulipas. Its low frequency in Infiernillo Canyon compared to the high frequency of Chapalote indicates that there was little interchange of cultivated corn varieties between the peoples represented by these two caves which are physically only about 75 miles apart.

Palomero Jalisciense. (Plate IX, B). A total of 37 cobs were assigned to this race which is described by Wellhausen *et al.* (1952) as a subrace of Palomero Toluqueño, one of the Ancient Indigenous races of Mexico. The subrace differs from the ancestral race in having thicker cobs and a higher kernel-row number. Among the living races of Mexico, it has been collected only in southern Jalisco at elevations of 2600 to 2700 meters. In comparison to Palomero Toluqueño, it is slightly

more vigorous, has a stronger root system, and is later in maturity. Also the ears are somewhat less tapering than those of Palomero Toluqueño. Wellhausen *et al.* (1952) suggested that these modifications had probably been brought about through introgression of Olotón, a race common in the high altitudes of the state of Chiapas, Mexico, and in Guatemala.

Tuxpeño. (Plate XI, A). Three unusually large cobs occurred which showed some resemblance to Tuxpeño, the predominating modern race of the lowlands of eastern Mexico. There is some question, however, whether these cobs are actually of this race. A combination of higher than average hybrid vigor and better than average growing conditions could have produced unusually large cobs of the race Breve de Padilla, which could be confused with cobs of Tuxpeño. On the other hand, it is possible that Tuxpeño, which occurs in this part of Tamaulipas today, reached there in prehistoric times and it is to avoid overlooking this possibility that we include here a specific mention of these three large cobs.

OTHER PARTS OF THE CORN PLANT

A total of 8525 specimens of other parts of the corn plant were identified. These included stalks, leaves, husks, tassels, and chewed quids.

Stalks

Like the cobs, the pieces of stalks, 47 in number, showed an evolutionary sequence with respect to size, the earlier ones being on the average more slender than the later.

Leaves

Nine leaves or leaf fragments among the specimens add no significant information since they are similar to the leaves of modern corn.

Husks

Like the cobs and stalks, the husks, a total of 219 pieces, showed an evolutionary sequence with respect to size, the earlier ones being on the average shorter than the later ones.

Tassels

An amazingly large number of tassels, tassel branches, and tassel fragments, 8099 specimens in all, were found among the vegetal remains. There is great variation among these; the later ones are indistinguishable from those of modern races of corn: some of the earlier ones have smaller spikelets. Although some students of maize (Anderson and Cutler, 1942) consider the tassel to be an especially useful organ in classifying maize, we have not yet been able to discover any clear-cut, diagnostic characters which will allow us to assign the tassels, as we have the cobs, to recognized races. We are, however, preserving all the specimens of tassels in the hope that some future student of prehistoric maize may see in them more than we have so far been able to discern.

The most puzzling aspects of the tassels is why they should have been preserved at all. Perhaps young tassels still containing their anthers served as a source of food. The ancient peoples who occupied this cave seem to have led a precarious existence with respect to their food supply and they chewed, presumably for the sugar they contained, a great variety of plants and plant parts. One of the specimens among the quids is undoubtedly that of the chewed young tassel since partly chewed staminate glumes can be identified in it. Also, we now know that corn pollen is rich not only in a number of amino acids but also in vitamins and minerals. Anthers filled with ripe pollen may be veritable little vitamin-mineral capsules and may have supplied some much needed elements to the diet. However, the majority of the prehistoric

tassel branches are those of matured tassels that have shed their pollen and lost their anthers. We can think of no use to which they might have been put for food or any other purpose except possibly a primitive ceremonial one.

Chewed Quids

The refuse contained a large number of chewed quids some of which, a total of 151, were identified as those of corn. Quids composed of chewed tassels have already been mentioned. Two other types were recognized: those produced by chewing young ears enclosed in husks and those resulting from chewing stalks. Both were probably chewed more for their sweetness than for the few calories which they added to a none-too-adequate diet. After identifying two partly chewed young ears in the refuse of La Perra Cave some years ago, we chewed their modern counterparts and found them sweet.

The majority of quids were those of chewed stalks. Chewing evidently began at one end of a piece of stalk and continued until the entire piece was thoroughly masticated and only the fiber remained. The process must sometimes have been interrupted for a few of the quids had unchewed sections of the stalk still attached producing a quid with a stem, a structure somewhat reminiscent of a modern lollipop (Plate XIII, D).

The chewing of both stalks and young ears must have been at the expense of subsequent grain production. Perhaps in this stage of culture being provident had not yet become a virtue and was seldom practiced.

TEOSINTE

We identified nine specimens of teosinte and three of maize-teosinte hybrids. The earliest specimen, a fragment of fruit case, occurred in feces in one of the lower levels of the Guerra phase dated at 1850–1200 B.C.

Other specimens occurred in the two succeeding phases. Several of these comprised clusters of spikes (Plate XII, A).

The specimens which we identified as maize-teosinte hybrids differed from those of teosinte in having thicker stalks and non-fragile rachises. The one illustrated in Plate XII, B is of particular interest in resembling spikes which we have produced by introducing one of the tunicate alleles into teosinte thereby replacing the highly indurated lower glume of teosinte with the herbaceous glume of tunicate maize. When we first encountered this specimen we wondered briefly whether it might represent the ancestral form of corn postulated by the late R. A. Emerson: a soft-shelled form of teosinte.* Because these specimens were borne on thicker stalks than the clusters of teosinte we concluded that they were maize-teosinte hybrids.

We cannot be certain whether the specimens identified as maize-teosinte hybrids are F_1 hybrids or segregates appearing in subsequent generations. They resemble F_1 hybrids in their non-shattering rachises but differ from typical modern F_1 hybrids in having single rather than paired spikelets.

The presence in the caves of remains of teosinte is puzzling. The seeds of teosinte are nutritious, having a higher protein content than those of corn (Melhus *et al.*, 1953), but are enclosed in hard bony shells from which they are difficult to remove. Although this can be done by popping if the moisture content of the seeds is right (Beadle, 1939) there is no evidence from the prehistoric remains that teosinte was used in this way. On the contrary Dr. E. O. Callen, who has made a study of the feces from these caves, has found a number of teosinte fruits with their hard bony shells still undamaged or un-

* In conversation.

changed. Since it is unlikely that the consumption of intact teosinte fruits provides any satisfaction or nutritional benefit to the consumer, there must have been some other reason for their use. Hernandez states that teosinte seeds are a cure for dysentery (Wilkes, 1967) and although it is doubtful that this is true, the inhabitants of the Infiernillo Canyon caves may well have believed it to be. Or did the Indians of this region perhaps practice the custom of planting teosinte in their corn fields to improve the corn as did those of western Mexico (Lumholz, 1902) or those of some parts of Guatemala (Melhus and Chamberlain, 1953)? The prehistoric specimens do not distinguish between the two possibilities. The finding of several fruits in a leather container in a pit extending down from a Palmillas floor suggests only that the fruits were regarded as having some value. The occurrence of maize-teosinte hybrids suggests that teosinte grew in or near the corn fields in prehistoric times although it is unknown in Tamaulipas today.

The early occurrence in this site of teosinte and of tripsacoid maize, presumably the product of teosinte introgression, may raise questions regarding the hypothesis of Mangelsdorf and Reeves (1939, 1959) that teosinte is a hybrid of maize and *Tripsacum* which may have occurred after the cultivation of maize began. There is still earlier evidence of tripsacoid maize, although not of either teosinte or *Tripsacum*, in the prehistoric cobs from caves in the valley of Tehuacán. In these sites, the tripsacoid corn first appeared as a single cob in the Abejas phase, 3400–2300 B.C., and had become well established in the later Ajalpan phase, 1500–900 B.C. The earliest corn in both Tehuacán Valley and in Tamaulipas is non-tripsacoid corn. The tripsacoid corn appears soon afterward and in Romero's Cave at the same level as teosinte. These several findings, although consistent with the hy-

pothesis of the hybrid origin of teosinte, by no means prove its validity.

TRIPSACUM

Slightly less puzzling, since it still grows in Tamaulipas, is the presence of *Tripsacum* in the refuse of the Canyon Infiernillo caves. Seeds of *Tripsacum*, like those of teosinte, are nutritious but are difficult to remove from the bony shells in which they are enclosed. They are not especially promising as a source of food yet must sometimes have been gathered for this purpose. Gilmore (1931) found fruits of *Tripsacum* in the prehistoric refuse of a cave in the Ozarks.

Five specimens of *Tripsacum* were found in the refuse and these included both staminate and pistillate spikelets (Plate XIII, B). We were not able to make positive identification with respect to species although one of the spikes seemed to bear a somewhat closer resemblance to *T. zopilotense*—which has not been collected in Tamaulipas—than to *T. dactyloides* which occurs there now.

SUMMARY

1. The vegetal remains uncovered in the refuse in three once inhabited caves in southwestern Tamaulipas, Mexico, are of particular interest in containing specimens of all three of the American Maydeae: maize, teosinte, and *Tripsacum* as well as hybrids of maize and teosinte.

2. The collection, comprising 12,014 specimens, included virtually all parts of the maize plant: stalks, leaves, husks, cobs, and tassels as well as chewed quids of various parts.

3. The corn is predominantly of the race Chapalote; about two thirds of all of the identified cobs are assigned to this race and its several subraces.

4. The predominance of Chapalote and its subraces suggests that the prehistoric corn and the agriculture which they represent have stemmed directly from southern Mexico where the wild corn with which domestication began was identified as a progenitor of the still existing Mexican race Chapalote.

5. Beginning at about 1850–1450 B.C. there is evidence of the introgression of teosinte into corn. More than half of the identified cobs were classified as Tripsacoid Chapalote.

6. Several specimens of maize-teosinte hybrids furnish direct evidence of the hybridization of maize and teosinte.

7. A new race, Breve de Padilla, which became the predominating race in the last phase, A.D. 1450–1800, may be a hybrid of Chapalote with the western Mexico race Harinoso de Ocho.

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PLATE VIII. A. The two cobs (left) of Pre-Chapalote; the lower from Guerra phase, 1850-1200 B.C., the upper from the Mesa de Guaje phase, 1200-400 B.C. The remaining four cobs are Early Chapalote. Both types are characterized by relatively soft glumes and rachis tissues. Actual size. B. Typical cobs of the race Chapalote from the Palmillas phase, A.D. 200-800. The stick inserted in one of the cobs may have served as a handle for holding the ear near fire to toast the kernels. Actual size.

PLATE VIII

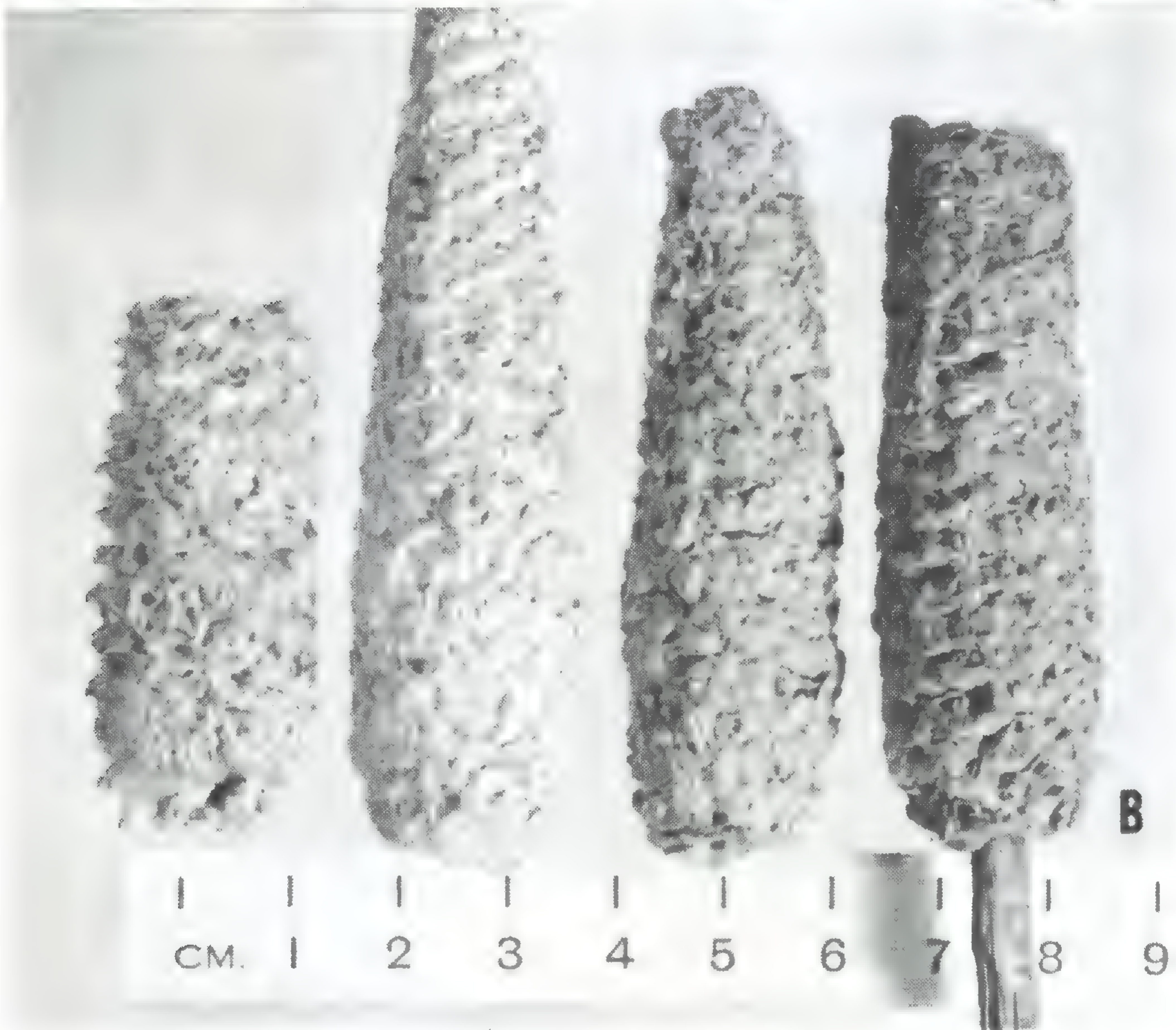
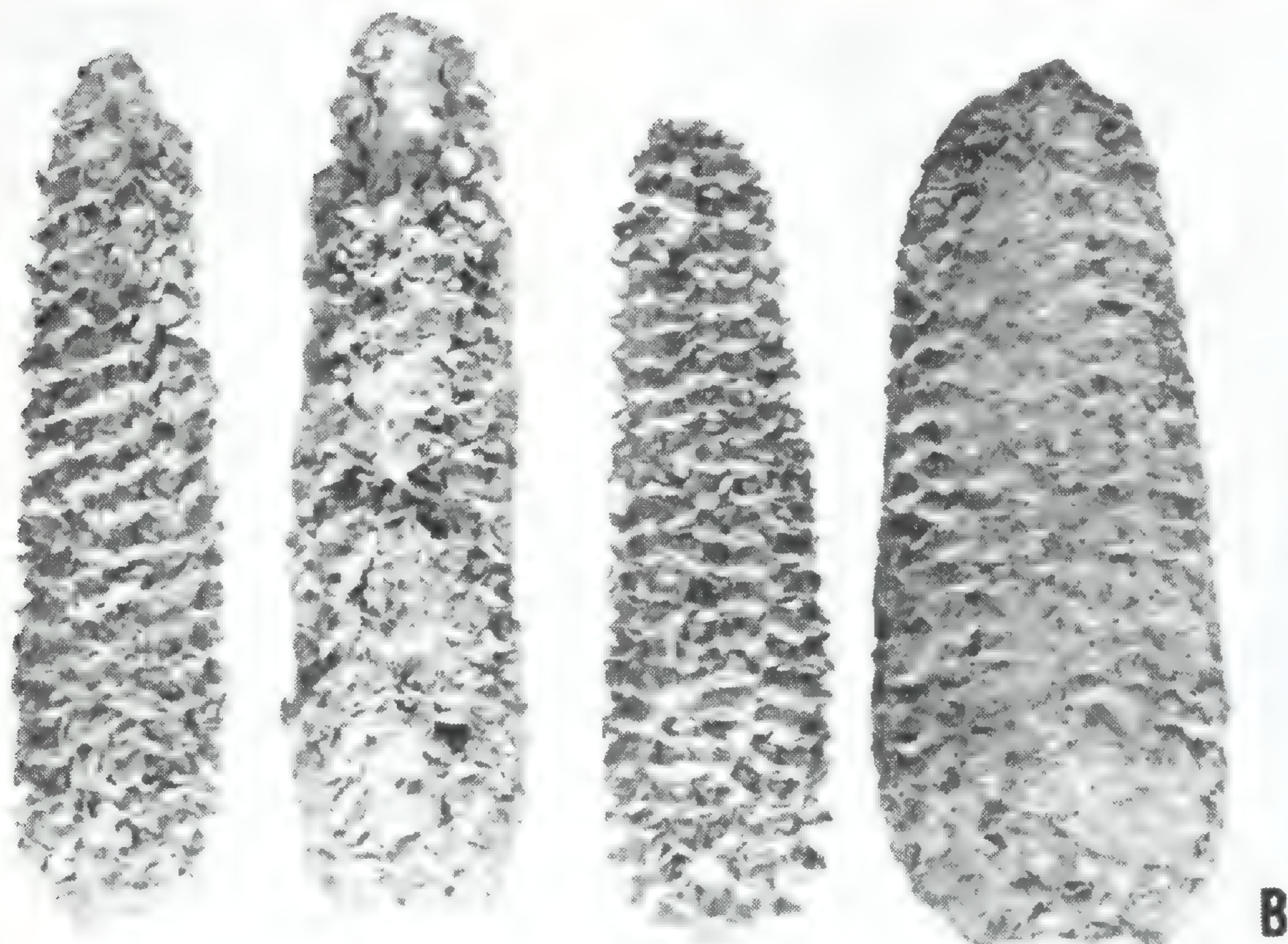
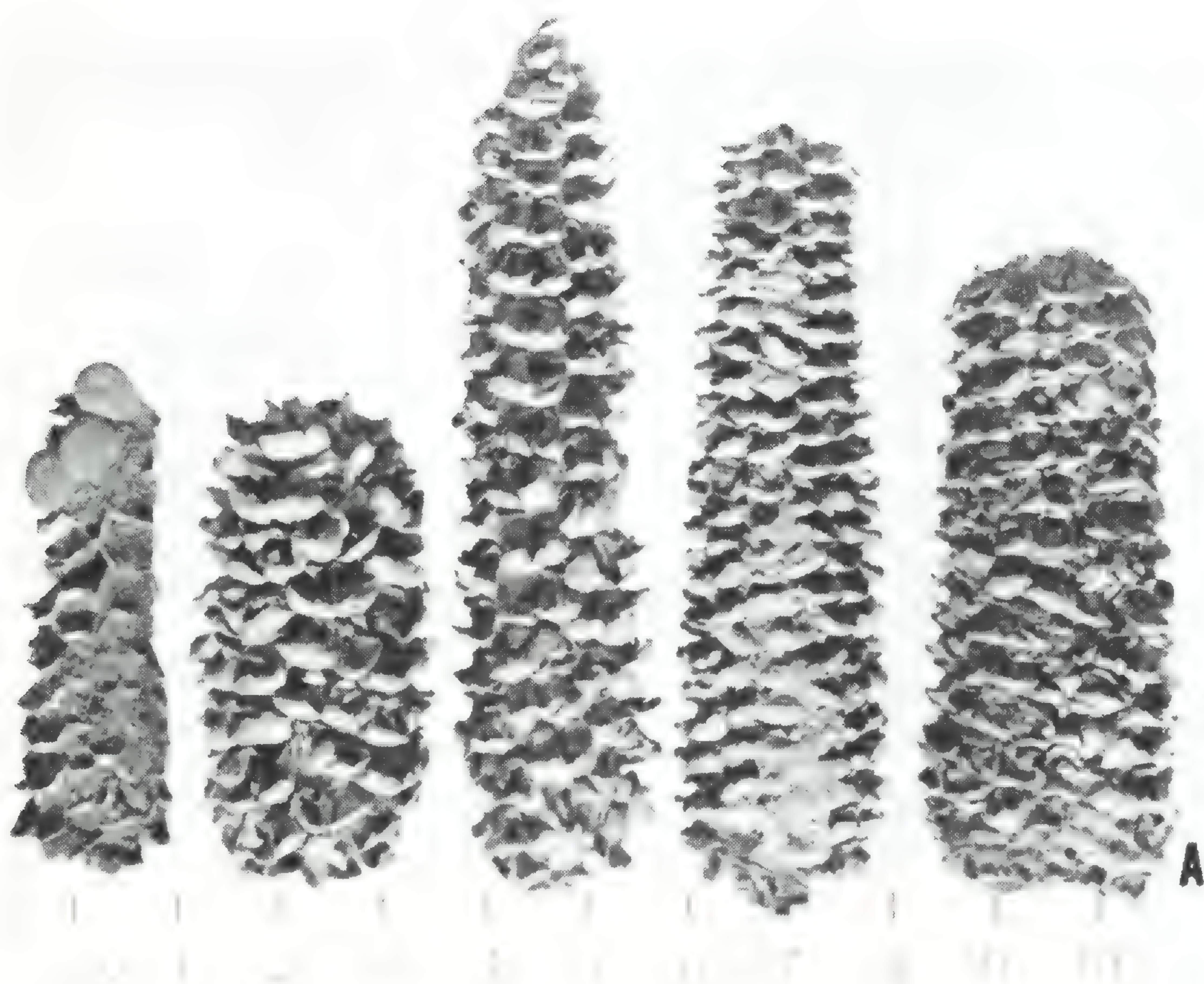
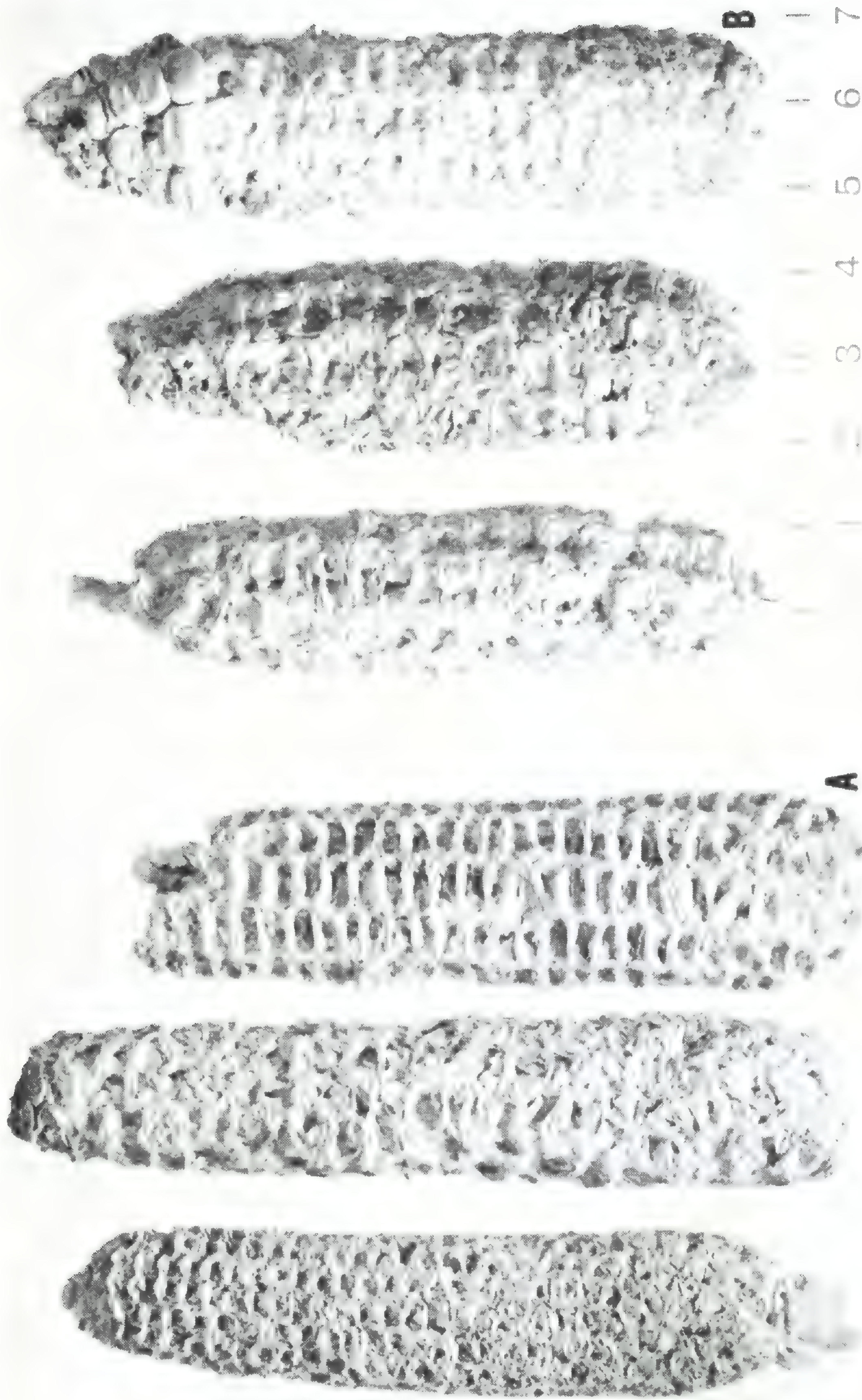


PLATE IX. A. Cobs of Tripsacoid Chapalote from the upper level of the Guerra phase, *ca.* 1400–1200 B.C. This maize, the predominating type in the cave, has indurated tissues of the rachises and lower glumes. When the other floral parts are lost the cobs with their stiff, often curved, lower glumes resemble a coarse file or rasp. The specimen at left still bears three kernels which have the brown pericarp color and round shape characteristic of Chapalote. Actual size. B. Cobs of Palomero Jalisciense, a popcorn race related to Palomero Toluqueño, one of the four Ancient Indigenous races of Mexico. Palomero Jalisciense is known today only in the state of Jalisco. Actual size.

PLATE IX

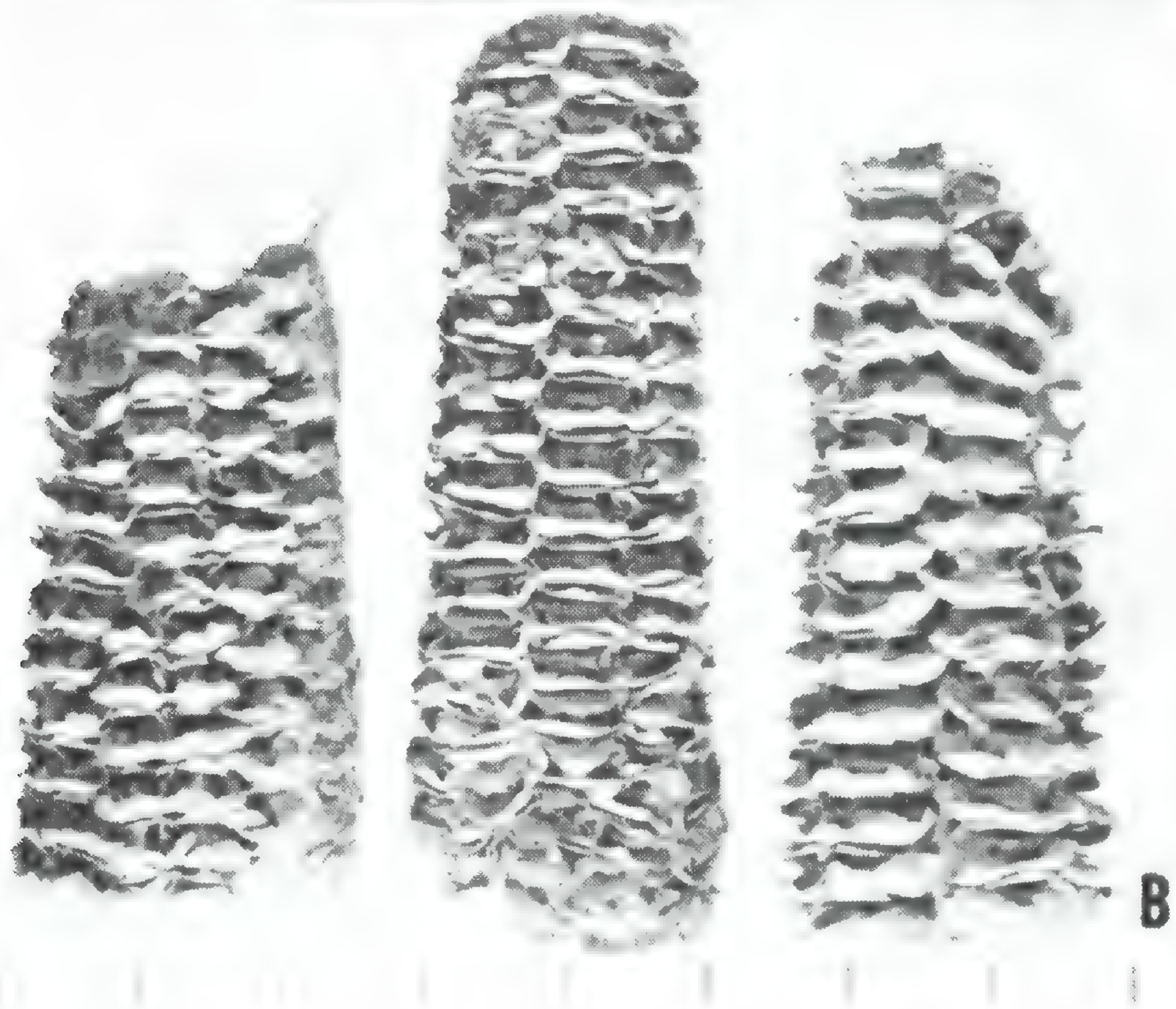
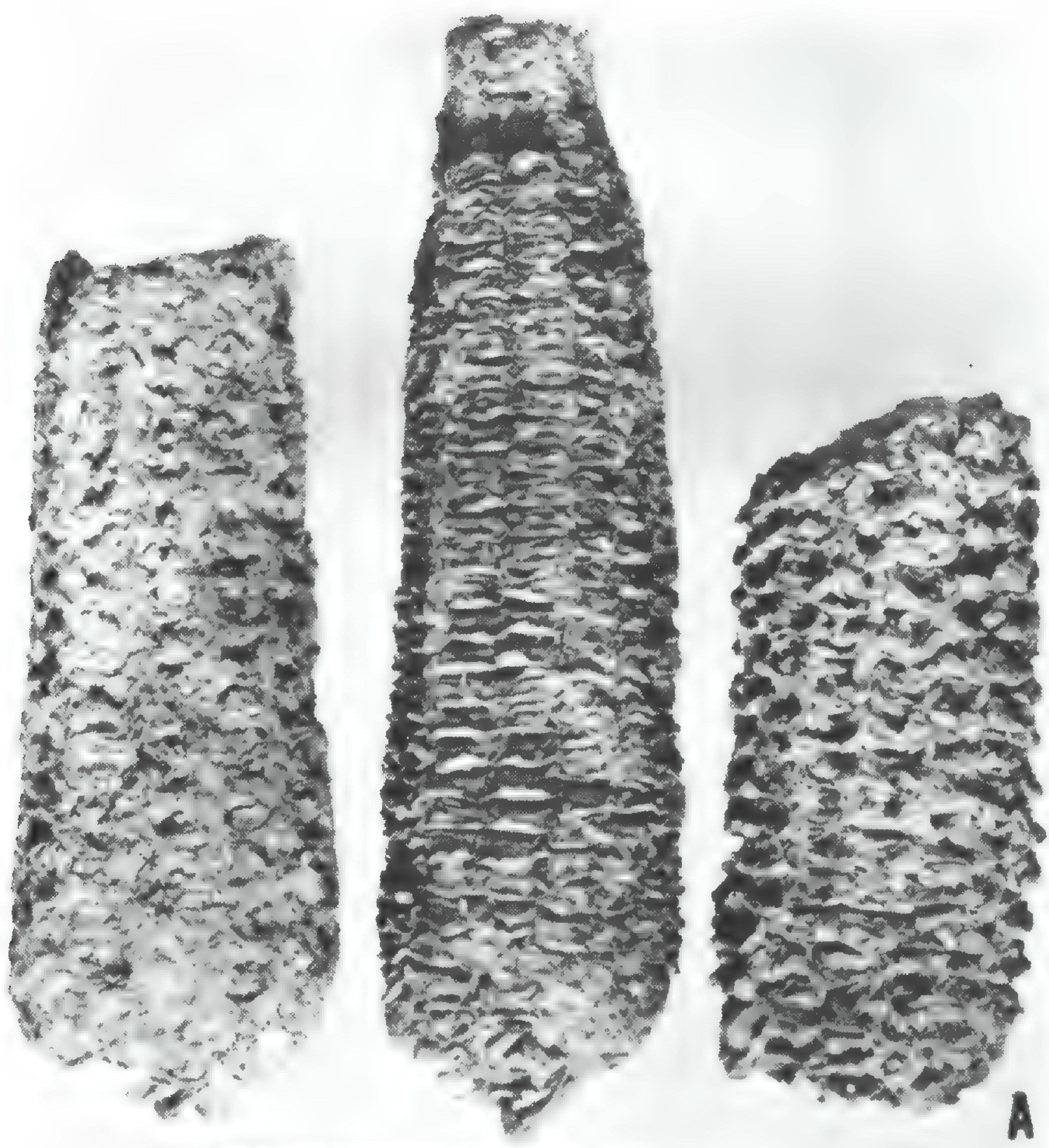




A. Second in frequency are the cobs of Breve de Padilla a race which may be the product of hybridizing Chapalote and Harinoso de Ocho. The latter from western Mexico has participated in the ancestry of a number of modern races including Tabloncillo and Jala in Mexico, and New England flint and Corn Belt dent in the United States. B. Cobs identified as belonging to the race Nal Tel which is the counterpart of Chapalote in the lowlands of eastern Mexico. This race, the predominating one in La Perra Cave in eastern Tamaulipas, was rare in Romero's Cave indicating that there was little interchange of corn varieties between the cultures represented by the two caves. Actual size.

PLATE XI. A. These cobs, of which there were only three, appeared in the San Lorenzo phase, A.D. 1050-1450. They are similar in their characteristics to those of the race Tuxpeño, one of the most productive of the modern races of Mexico, but they may be unusually large cobs of Breve de Padilla, the predominating race in the upper levels of the refuse. Actual size. B. These cobs may be of the race Harinoso de Ocho which is postulated to be the putative ancestor of Breve de Padilla, illustrated in Plate X, and of several other productive races.

PLATE XI





A. A cluster of teosinte spikes with a number of the fruits exposed to view. These, like the fruits of modern Mexican teosinte, are triangular in shape and in this respect differ from the fruits of Guatemalan teosinte which are trapezoidal. B. A spike identified as that of a maize-teosinte hybrid. This differs from spikes of teosinte in having a solid rachis and herbaceous, instead of indurated, lower glumes. Note that the stalk on which it is borne is thicker than the stalks of teosinte shown in Plate XII, A. Actual size.

PLATE XIII. A. Tassel branches from the San Antonio phase, A.D. 1450–1800. All specimens are similar in their botanical characteristics to the staminate tassel branches of modern corn where the spikelets occur in pairs, one member sessile, the other pedicelled. Actual size. B. The pistillate part of a prehistoric spike of *Tripsacum* and the staminate part of another spike. Why *Tripsacum* should have been collected and preserved in the cave is puzzling. Actual size. C. Some of the cobs of Tripsacoid Chapalote are fragile like the spikes of teosinte and break up into disc-like segments (left) which resemble closely the segments of some derivatives of modern maize-teosinte hybrids (right). These prehistoric specimens furnish indirect evidence of the hybridization of maize and teosinte. Direct evidence of such hybridization is provided by the maize-teosinte hybrids illustrated in Plate XII, B. D. Quids, the product of chewing tassels (left, center) and a stalk (right). Young ears enclosed in husks were also sometimes chewed. Actual size.

PLATE XIII



BOTANICAL MUSEUM LEAFLETS

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CATALOGUE OF INFRARED SPECTRA OF FOSSIL RESINS (AMBERS) I NORTH AND SOUTH AMERICA¹

BY

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FOSSIL resins are of interest to the mineralogist, palaeontologist, botanist, entomologist, chemist, and archaeologist, but, because their study straddles these many fields, they have not received comprehensive attention from any quarter. During the 19th Century, mineralogists described and named well over 100 fossil resins, mostly of European origin, and botanists and entomologists studied plant and insect inclusions, primarily in Baltic

¹Grateful acknowledgment is made for funds to support this study from National Science Foundation grants GB-1312 and GB-2397 at Harvard University and GS-739 and GP-4729 at Vassar College. Also financial assistance was provided to Professor Langenheim by the Radcliffe Institute for Independent Study and to both Professors Langenheim and Beck by the American Philosophical Society for the Advancement of Useful Knowledge. Mr. Gil Hillman, Mr. Anthony Placeres and Mr. Sumner Slavin assisted with preparation of the spectra and Mrs. Patty Shepard prepared the illustrations. Appreciation is likewise expressed to Professor E. S. Barghoorn for his continued interest and support of the project as well as his criticism of the manuscript and to Mr. James Doyle for his helpful discussions of Cretaceous stratigraphy and floras.

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amber. In the New World there are no fewer resins, but, since they have been studied by biologists rather than mineralogists, few have been given names.

Even now, the only reasonably inclusive listing of fossil resin occurrences, restricted largely to the named varieties, are to be found in the back pages of standard works on mineralogy or mineral chemistry, such as those of Dana (1895), Hintze (1933) or Doelter and Leitmeier (1930). Their description by standard mineralogical procedures, which are ill suited to complex, largely non-crystalline, organic materials, does not provide an acceptable basis for classification. It is indeed no exaggeration to say that fossil resins have not yet been ordered into a classification system. Mineralogical compendia make broad distinctions between "families" containing or lacking succinic acid, sulfur or nitrogen, but these superficial criteria do not reflect any meaningful relationship in establishing a natural classification system.

Paelt (1953) has suggested a system ordered by geologic age and botanical origin. The former criteria, unfortunately, have had to be based on meager and scattered published evidence. Most often, the botanical origin, which is based on associated fossil plant remains, is indicated without supporting evidence because of lack of available data in the literature. Botanical source unquestionably is the most significant basis for classification of fossil resins, since they are plant products the chemical composition of which is genetically controlled (Mirov, 1961; 1967). Also study of the botanical source of fossil resin through geologic time provides an opportunity to observe evidence of biochemical evolution within the populations that produce the resin. Resins from some populations appear to have a relatively stable composition through millions of years, whereas others have changed considerably. The determination of the origin

of resin, however, is a difficult task because of the changes which resins undergo in the process of fossilization. Resins polymerize with age, presumably by a free-radical mechanism. As a result, the fossil product is a macromolecule of high molecular weight, largely insoluble, and not amenable to most of the usual methods of attack used in elucidating the structures of organic compounds.

We have found infrared spectroscopy a useful technique in botanical investigations of both fossil and modern resins at Harvard University and in the classification of fossil resins for archaeological ends at Vassar College. We now hope to use our diverse interests and competences to undertake the large task of a systematic study of fossil resins. The goal is to classify them first relatively, i.e. sorting them into groups of resins which share the same gross composition as revealed by their infrared spectra. We eventually expect to determine their botanical source by comparison of the infrared spectra of recent and fossil resins corroborated wherever possible by paleobotanical data. Some results of this collaboration have been published previously (Langenheim and Beck, 1965).

Infrared spectroscopy is useful particularly in comparing fossil and recent resins because polymerization preserves all simple functional groups of the recent resin with the exception of carbon-carbon double bonds. Also skeletal frequencies are damped but not usually extinguished completely. Thus, a similarity remains between the spectra of recent and fossil resins in that certain absorption peaks can be matched one-to-one, although the intensity of these peaks is usually much weaker in the fossil resins than it is in the recent ones, especially at longer wave lengths.

Over the past few years, we have prepared infrared spectra of well over a thousand fossil resins and several hundred present-day resins. It now seems appropriate

to make this large body of evidence accessible to interested research workers in the form of a catalogue which will be divided into three sections: I, North and South American; II, Europe; III, Asia and Africa. A fourth section probably will present spectra of resins from living plants.

We have attempted to procure as many specimens as possible of each kind of fossil resin from the leading collections of the New and Old World. Samples used in this section were obtained from the Harvard University Botanical Museum Paleobotanical Collections; Harvard University Mineralogical Collections; Harvard University Entomological Collections; Museum of Paleontology, University of California at Berkeley, United States National Museum (Smithsonian), New York Museum of Natural History and Museum für Naturkunde, East Berlin.

Since infrared spectroscopy is not yet a method widely used by botanists and mineralogists, we will here include a brief discussion of the major absorption bands of the fossil resins and their significance. Infrared radiation is absorbed by matter to provide the necessary energy for the motion of atoms within a molecule. These motions may be relatively simple (stretching and bending of individual bonds between two atoms) or they may be very complex (involving larger portions of the carbon skeleton of the molecule). The simpler motions predominantly lead to absorption at low wave lengths ($2.5\text{--}8\ \mu$; 4000 to 1250 cm^{-1}). Because they are essentially independent of the rest of the molecule, their absorption bands are remarkably stable in position and are readily assigned to specific functional groups. Thus, the first absorption band of fossil resins at $2.9\ \mu$ (3500 cm^{-1}) is due to the stretching of hydrogen-oxygen bonds; the bending motion of these bonds causes absorption at about $6.1\ \mu$ (1650 cm^{-1}).

Some of the hydroxyl groups responsible for these two bands without doubt pre-exist in the resin, but others are the result of atmospheric water vapor taken up by the sample in the course of its preparation (Beck *et al.*, 1966). The group of more or less well resolved absorptions near $3.4\ \mu$ ($2950\ \text{cm}^{-1}$) is due to the stretching of carbon-hydrogen bonds; the bending motions of these same bonds lead to absorption near $6.8\ \mu$ ($1470\ \text{cm}^{-1}$) and $7.25\ \mu$ ($1380\ \text{cm}^{-1}$).

The remaining prominent band in the lower region is due to the stretching of carbon-oxygen double bonds. This so called carbonyl band usually occurs near $5.8\ \mu$ ($1700\ \text{cm}^{-1}$) in the fossil resins. All these absorption bands are almost uniformly typical of all fossil resins and, therefore, of limited diagnostic value. Only the position, intensity, and resolution of the carbonyl band show significant variation.

The upper region of the spectra (8 to $16\ \mu$; 1250 to $625\ \text{cm}^{-1}$) is more difficult to interpret in terms of chemical structure, but it is nevertheless more useful than the lower region because it shows greater variety. Of prime importance is the region between 8 and $10\ \mu$ (1250 and $1000\ \text{cm}^{-1}$), where absorption is due to carbon-oxygen single bonds. Since these vibrations are substantially influenced by the carbon skeleton of the entire molecule, it is rarely possible to assign these bands to very specific structural features. However, as a kind of fingerprint of a fossil resin, this upper region is the one that we most often rely upon to classify resins into groups which are not only recognizable as having similar basic structures, but which we can increasingly relate to recent resins, and thus obtain important evidence about the botanical origin of the fossil resins.

Absorption bands above $10\ \mu$ ($1000\ \text{cm}^{-1}$) are, in general, still more difficult to assign and must therefore be used

mainly as fingerprints. But there are a few major exceptions. Bending motions of hydrogen atoms attached to unsaturated carbon atoms lead to absorptions which are highly characteristic and which yield useful structural information. In the fossil resins, the most important of these is the sharp band near $11.3\ \mu$ ($885\ \text{cm}^{-1}$) which can be attributed to out-of-plane bending of the two hydrogen atoms of a terminal methylene group. The presence of this band in the spectrum of a fossil resin is of particular interest, because it is also a feature of a number of resin acids which have been isolated from recent resins (agathic acid, copalic acid, catavic acid, eperuic acid). The absence of this band in fossil resin spectra, however, must be interpreted with caution, since terminal methyl groups are easily oxidized. The lack of an $11.3\ \mu$ ($885\ \text{cm}^{-1}$) band in the spectrum of a fossil resin may, therefore, indicate either that the resin never had a terminal methylene group or that this group has been oxidized as a result of long exposure. The hydrogen atoms attached to aromatic rings also cause easily recognizable absorptions in the upper regions. They are rare in fossil resins, but, when they occur, they permit immediate assignment of the resin to the few botanical sources characterized by aromatic components.

All of the spectra were made from amber in the solid state which was dispersed in potassium bromide pellets (Langenheim and Beck, 1965; Beck *et al.*, 1965). The Perkin Elmers Model 137 spectrophotometer was used for the samples reported in this section.

The spectra curves reproduced here can, of course, be only a small fraction of those now recorded in both of our laboratories. To make the selection, we have compared all the spectra of each species or variety in order to choose a few spectra which best represent the group as a whole. In addition, we have included spectra of special

interest since they show features not shared by all members of the group.

We should like to warn researchers not to put too much weight on a single infrared spectrum of any fossil resin. Resins are mixtures of appreciable heterogeneity, and the small samples used to prepare spectra may well differ significantly in composition, even when taken from a single specimen. It is always advisable to run two or more spectra of a given specimen and to rely only on those features which are common to all or, at least, to most spectra.

Relatively few of the North and South American ambers have been characterized chemically or physically and assigned mineralogical species names, as numerous of the European ambers have been. In some instances, however, paleobotanical remains of considerable significance in determining the botanical source of the amber have been reported in New World deposits. For this reason, botanical information regarding the kinds of trees that might have produced the amber, in addition to the manner in which the resin may have been produced, have received particular attention in this presentation. Confusion regarding stratigraphic data and, hence age assignments of the amber-bearing strata, are discussed where relevant to an understanding of the rapid evolutionary changes which occurred in some of the possible resin-producing components of Cretaceous floras in particular. Spectra of modern resins will be compared with those of ambers in some cases. Only general comments regarding the origin of the amber will be made, however, since this paper is designed primarily as a catalogue. Detailed discussion of botanical origin will be presented elsewhere.

CRETACEOUS AMBER

Amber from Cretaceous beds have been reported in considerable amounts from the Kuk River drainage of the Alaskan Arctic Coastal Plain, from the beach of Cedar Lake, Manitoba, Canada, and from numerous occurrences along the Atlantic Coastal Plain from Massachusetts to South Carolina. Also a small amount has been recorded from Baja, California, Mexico. Spectra have been made from specimens from the above localities. Although amber has also been noted to occur in Cretaceous rocks from Hardin County, Tennessee (Ross, 1956), Ellsworth County, Kansas (Schoewe, 1942), the Black Hills of South Dakota, Eagle Pass, Texas, Mt. Diablo, California, as well as other localities, samples of these have not been available as yet for analysis.

The Alaskan amber will be discussed first because its stratigraphic relations and associated plant fossils have been investigated more intensively than for other Cretaceous ambers. These studies provide background for interpretation of the botanic source in terms of the infrared spectra.

Alaskan Amber

Amber is widespread in Upper Cretaceous coal and carbonaceous shales along the Kuk River drainage (Kuk, Ketik and Kaolak Rivers) of the Alaskan Arctic Coastal Plain (Langenheim, Smiley, and Gray, 1960; Smiley, 1966). Reworked amber occurs also ubiquitously in Pleistocene beds and along recent stream deposits in this region. Several lines of evidence indicate that these Cretaceous amber-bearing beds are of non-marine origin, and age determinations rest entirely on the abundant plant megafossils and microfossils. The older Kuk flora, characterized by ferns of varied kinds and a mixture of primitive and modern conifers, is considered Cenomanian

(earliest stage in the Upper Cretaceous) in age (Smiley, 1966); only a few amber samples were found in these strata. More amber occurred in the Ketik beds to which Smiley assigns a Turonian age. These beds contain the earliest record of abundant and varied angiosperms and the dominant Ketik conifers are modern types referable to extant genera in such families as Taxodiaceae (*Sequoia*, *Sequoiadendron*, ? *Taxodium* and *Juniperus*), Pinaceae (*Pinus*, *Picea* and ? *Larix*) and Taxaceae (*Cephalotaxus* and ? *Torreya*). Most of the amber occurred in association with the Kaolak flora which Smiley designates as Senonian in age. It is characterized by taxodiaceous conifers (*Sequoia*, *Sequoiadendron* and ? *Taxodium*) and ? *Torreya* in the Taxaceae. Gray (Langenheim, *et al.*, 1960) noted an abundance of conifer pollen in this flora with taxodiaceous pollen the dominant type. Pine and spruce pollen also occurred frequently, but the rarity of megafossils suggests that the latter conifers may have inhabited slopes or uplands some distance from lowland depositional sites. Langenheim *et al.* (1960) concluded that the source of this amber was taxodiaceous trees growing close to lakes, coastal swamps or other water bodies from the evidence: 1) the amber has always been found with abundant taxodiaceous remains, 2) the pinaceous pollen was derived from upland sources.

This Alaskan amber has been described neither chemically nor physically and has not been given a mineralogical name. Some of the material is transparent, although much is opaque. The clear amber varies in color from light yellow to red, deep golden brown and almost black. The opaque material varied commonly from a beige to molasses color. Most of the transparent amber is crack-free and has a conchoidal to subconchoidal fracture, whereas the opaque amber is commonly granular. Langenheim *et al.* (1960) indicate that most clear pieces

do not contain inclusions, although small bubbles and/or small plant fragments are abundant in some specimens. Most unbroken specimens are small (one-eighth inch in diameter) teardrop masses, subcylindrical pieces up to one-fourth inch in diameter or irregularly mammillary blobs. The teardrops may have dropped from the trunk or branches, and the cylinders may have broken from hardened runnel of resin attached to the surface of a branch. All of these shapes tend to demonstrate resin hardened in the atmosphere. Several occurrences of amber in coal with woody texture, however, suggest that at least part of the amber was derived from resin within the trunk of tree and thus not in a position to trap insects or wind-blown plant debris.

Twenty-two spectra were run of Alaskan amber representing samples varying in color and other physical properties. Nineteen specimens were from the Kaolak River and three from the Ketik River localities; none were available from the Kuk River. Most of these collections were from placer deposits, although at two localities the amber was collected *in situ*. All of the material is from the collections of the Museum of Paleontology, University of California at Berkeley. Three patterns appeared among the 22 spectra run (Plates XIV and XV). The most typical pattern is Type II (H-332); 15 spectra are of this kind. The spectra typical of amber from the Raritan formation from Kreischerville, Staten Island, New York, is similar to Alaska Type II in the carbon skeleton. Type I (H-313) is a more generalized pattern (i.e., more flattened with less pronounced bands) and is represented by three spectra. Type III (H-318 on Plate XV) occurs only in two spectra but is quite similar in the carbon skeleton to that of the amber from the Upper Patapsco Formation from Washington, D.C. There are, however, differences between the pairs Alaska

II and Kreischerville, on the one hand, and Alaska III and Washington, D.C., on the other, in the intensity and resolution of the carbonyl band. The $11.3\ \mu$ ($855\ \text{cm}^{-1}$) band is most pronounced in Alaska II and Washington, D.C. (H 173 on Plate XV).

Spectra of resin from various living members of the Taxodiaceae and Pinaceae are being run presently to see if correlation can be established with these Alaskan types. The Taxodiaceae are of particular interest, since associated plant remains with the Alaskan amber point to this possible origin. As yet, however, relation of this amber to either members of the Pinaceae or Taxodiaceae is not evident, but further investigation of the modern resins is necessary.

Atlantic Coastal Plain Amber

Amber for spectral analysis has been obtained from twelve localities along the Atlantic Coastal Plain from Massachusetts to South Carolina (Fig. 1). In most cases, the amber was reported to occur in Potomac, Raritan or Magothy beds. Controversy has existed regarding the age of these stratigraphic units (Spangler and Peterson, 1950; Dorf, 1952; Steeves, 1959). Recent palynological studies, however, have essentially confirmed age assignments previously based on plant megafossils (Berry, 1909, 1910, 1911a,b,c, 1914, 1916 *et al.*; Dorf, 1952).

The Potomac Group is the basal unit of the Atlantic Coastal Plain Cretaceous sequence in Maryland, Delaware and Virginia. It typically underlies the Raritan and Magothy Formations in Maryland and Delaware but is absent to the north in New York, New Jersey and Massachusetts, where the Raritan is the oldest Cretaceous unit. The Potomac Group appears to be entirely Lower Cretaceous in age (Brenner, 1963), with the Patuxent Formation being Barremian, the Arundel Formation

CRETACEOUS

I	Alaska (Arctic Coastal Plain)	22
II	Manitoba, Canada (Cedar Lake)	11
III	Atlantic Coastal Plain	
	1. Kreischerville, New York	7
	2. Martha's Vineyard, Massachusetts	1
	3. Harrisonville, New Jersey	2
	4. Cliffwood, New Jersey	1
	5. Bordentown, New Jersey	3
	6. Roebling, New Jersey	11
	7. Kincora, New Jersey	3
	8. Pemberton, New Jersey	2
	9. St. Georges, Delaware	1
	10. Washington, D.C.	2
	11. Magothy River, Maryland	5
	12. Charleston, South Carolina	3
IV	Baja California, Mexico	4

EARLY TERTIARY

V	Seattle, Washington	5
VI	Dominican Republic	7
VII	Chiapas, Mexico	30
VIII	Pará, Brazil	2

UNKNOWN AGE

IX	Guayaquil, Ecuador	3
X	Girón, Colombia	6
XI	Medellín, Colombia	6
XII	Cañon Diablo, Arizona	1
XIII	Greenland	2
XIV	Montana	9

Number of spectra for all localities are indicated.

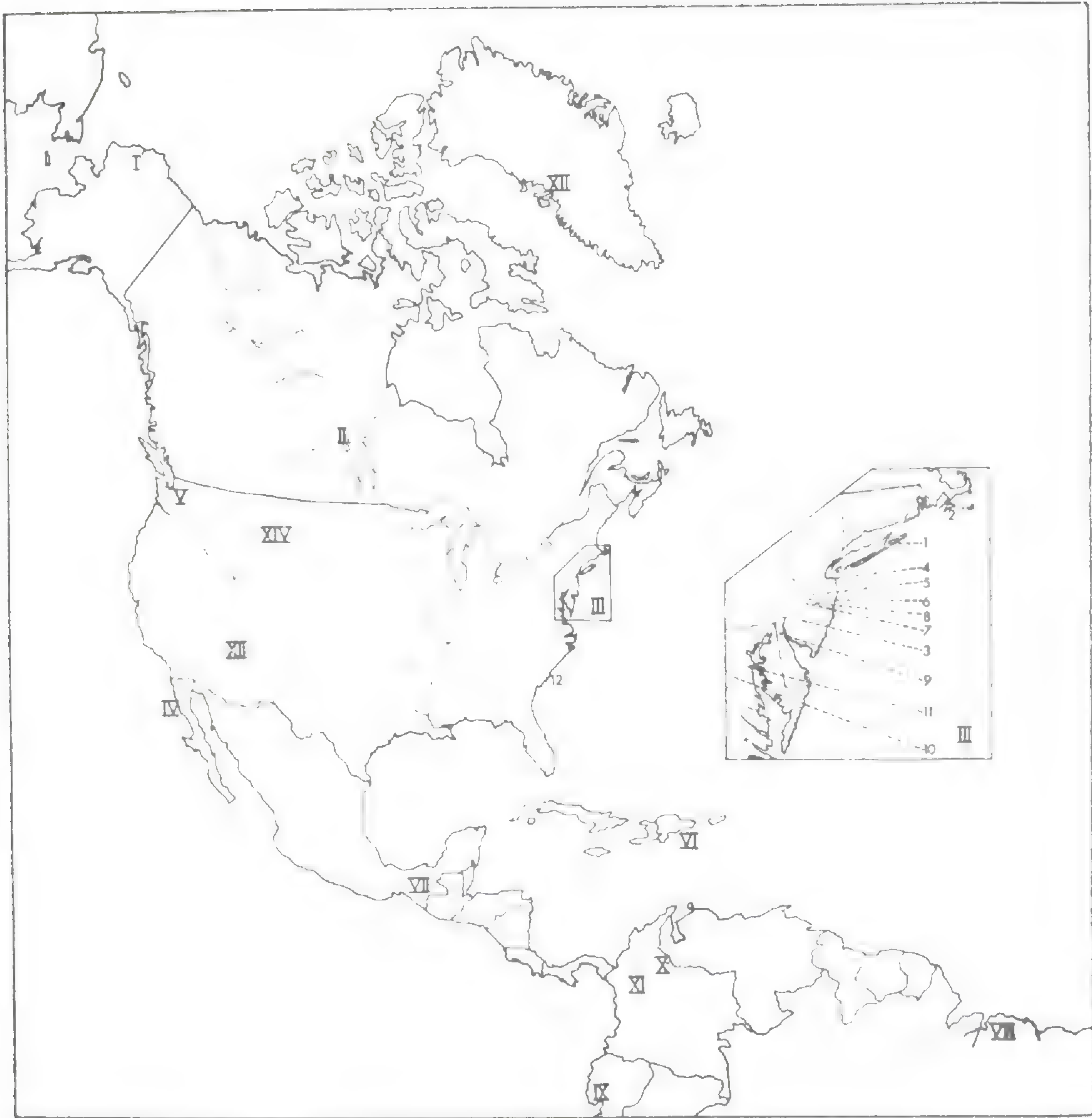


FIGURE I. Location of samples of amber in North and South America from which infrared spectra were run (see explanation on opposite page).

being Aptian, and the Patapsco Formation being restricted to the Albian Stage.

The Raritan Formation, on the other hand, is Upper Cretaceous (Cenomanian-Turonian Stages), according to the palynological investigations of Groot, Penny and Groot (1961) and Kimyai (1966). The overlying Magothy Formation is Turonian-Coniacian (Early Senonian) in age (Groot, Penny and Groot, 1961 and Stover, 1964).

It is impossible to sort out the stratigraphic difficulties for most of the Atlantic Coastal Plain amber deposits from the available literature. It is most important to be aware of the age differences of these deposits, however, and possible confusion regarding them. The age is particularly significant in regard to change in floras and seemingly rapid evolution of coniferous elements that could have been the amber producers. Although angiosperms were rapidly evolving during this time, none except *Liquidambar* are known to have been resin-producing plants.

Washington, D.C. Amber

A single sample of amber from the Upper Patapsco Formation was collected by J. Doyle from the corner of Branch Ave. and O Street SE, Washington, D.C. The amber came from a clay associated with a lignite bed at the top of typical Patapsco clays (Lower Cretaceous, Albian Stage) which are directly overlain by cross-bedded sands thought to be Upper Cretaceous by C.F. Withington (Doyle, 1966). Doyle analyzed the plant microfossils from these beds and found a typical Upper Patapsco assemblage as established by Brenner (1953). Brenner's palynological studies indicate that the gymnosperms of the Potomac forest included members of the Podocarpaceae, Araucariaceae (including *Araucariacites australis* Cook., which is comparable to modern *Araucaria* and

Agathis), Pinaceae and the Cupressaceae-Taxodiaceae complex. Particularly abundant in some localities is *Inaperturopollenites dubius* (Potonie and Venitz) Thomson and Pflug, which is considered to be a member of either the Taxodiaceae or Cupressaceae. *Brachyphyllum-Pagiophyllum* represented other common coniferous families which are now extinct. Brenner further states that these Potomac forests were probably similar in character to the warm-temperate gymnosperm and fern forests of New Zealand today. In these forests, Podocarpaceae and Araucariceae are the dominant trees with a luxuriant growth of ferns characterizing the understory. He adds, however, that the presence of cycads and schizeaceous plants suggests more tropical conditions than exist in present New Zealand forests.

Two spectra were run from a single piece of amber from this O Street sample. The spectra are similar and represented by II 173 (Plate XV). This spectrum resembles also Type III from Alaska (Plate XV).

Kreischerville Amber

Hollick (1905) reported considerable quantities of amber from a Cretaceous deposit at Kreischerville, Staten Island, New York. He stated that the beds were an eastward extension of the Amboy Clay and sand series of New Jersey and thus included in the Raritan formation. He further continued that they were "middle Cretaceous in age and approximately equivalent of the Cenomanian of Europe. . . ." Hollick and Jeffrey (1909) indicated that both the Raritan and Cliffwood (Magothy) Formations were present at Kreischerville but that only the Raritan beds here were plant-bearing. Unfortunately, the stratigraphic position of the Kreischerville deposits has not been investigated recently.

The amber occurs in strata containing closely packed

masses of leaves, twigs and fragments of lignite and charred wood. Most of it was distributed irregularly in the matrix of relatively thick accumulations of comminuted lignite. The amber occurs commonly as small teardrops or in irregularly shaped fragments varying from the size of a pin head to a hickory nut. It is generally transparent and yellow or reddish in color, although some is opaque and grayish white.

In 1907, Gies' chemical analysis indicated the following percentage elementary composition: C, 78.5; H, 9.5; S, 0.25; O, 11.75. On destructive distillation, succinic acid appeared to be formed and a considerable "quantity of volatile sulphide was evolved." Ash content was only 0.1%.

Because the amber at Kreischerville occurs in close association with leafy twigs of *Sequoia heterophylla* Vel. and *S. Reichenbachii* (Gein.) Heer, Hollick thought that *Sequoia* might also be the source of this amber. He indicates, however, other coniferous remains found in the Kreischerville clay which might have contributed amber: *Widdringtonites Reichii* (EH.) Heer, *Juniperus hynoides* Heer, *Dammara microlepis* Heer and *Pinus* sp.

Jeffrey and Chrysler (1906) and Jeffrey (1907), on the other hand, studied the lignites from Kreischerville and concluded that *Pityoxylon* (Pinaceous) was the only genus which contained amber. This "pitoxylid lignite" contained masses of large pieces of amber; smaller fragments were contained in the amber-bearing strata. "The amber enclosed in the lignite appears both in translucent shining condition and in dull ochraceous modification." It not only occurs in "pockets or nuggets but also as fine yellow threads or streaks corresponding to the normal resin passages in the wood."

Thus, only both a possible taxodiaceous and pinaceous source have been suggested for the Kreischerville amber.

Six amber specimens from Kreischerville were run from Harvard Botanical Museum Paleobotanical Collection #52812. All of the spectra were similar to that shown in H 321 (Plate XIV). Thus, the possibility of two sources did not become evident in the particular samples analyzed. The similarity of the spectra from Kreischerville and from the Koalak River in Alaska is noteworthy. Although stratigraphic data for the Kreischerville deposit have not recently been critically assessed, it appears that the amber here is probably only slightly older (Cenomanian) than the Koalak amber (Senonian). Although a taxodiaceous source is strongly indicated for at least part of the amber in both localities, infrared spectra of modern resins of representatives of this family have not as yet provided corroborative evidence. This has been true for the Pinaceae as well.

Magothy River Amber

Troost (1821) described amber associated with lignites at Cape Sable, Magothy River, Anne Arundel County, Maryland. These are the strata which later were designated as the Magothy Formation (Little, 1917). Troost indicated that this amber occurs generally as grains "from the size of a mustard seed to that of pieces from 4 to 5 inches in diameter." Most of it is opaque, varying from brown to yellowish grey; transparent specimens seldom are found. Also some of it is "earthy", occurring as friable, porous masses.

Although Troost was interested in the kind of wood with which the amber was associated, he was unsuccessful in identifying the lignites. Knowlton (1896), however, found at this locality a log which contained small pieces of amber. Poor preservation of wood and its tendency to disintegrate with exposure left its generic determination open to question. Knowlton finally concluded,

however, that "as nearly as can be made out, the structure is that of *Sequoia* or *Cupressinoxylon* as the wood is known in the fossil state." He named it *Cupressinoxylon Bibbinsi*, and suggested that this origin was supported by Fontaine's recognition of 15 species of *Sequoia* from similar lignites found elsewhere in the Potomac Group.

Hollick and Jeffrey (1909) concluded that most of the conifers found in Raritan strata, which had previously been referred to Podocarpaceae, Cupressaceae or Taxodiaceae (Sequoiineae), belonged to the Araucariaceae. They recognized, however, the abietinious genera *Prepinus* and *Pinus*. Penny (1947), on the other hand, suggested that some of the Raritan conifers that Hollick and Jeffrey considered araucariaceous were taxodiaceous. For example, *Sequoia Reichenbachii* (Geinitz) Heer, which is synonymous with *Geinitzia Reichenbachii* (Geinitz) Holl. and Jeff., Penny considers to be essentially the same as *Sequoia ambigua* Heer. He suggests that these species, as well as others of *Geinitzia*, are taxodiaceous rather than araucariaceous. Araucarian remains, nonetheless, are common in the Magothy flora of New Jersey and Delaware.

Five spectra were run of specimens from USNM collection #72871. This amber was generally opaque with some color variation from beige to brown. Four of the spectra gave the pattern shown in H 361 (Plate XVII). Another specimen from this same collection gave the typical Baltic Succinite pattern (Langenheim and Beck, 1965).

A taxodiaceous source is indicated from the wood in which the amber was enclosed, although the identification of this wood is tenuous. The spectral type of this amber (Plate XVIII) forms a family of amber including those from St. George, Delaware (H 357), Bordentown, N.J. (H 225), Cliffwood, N.J. (H 422) and Kincora,

N.J. (H 367). This type is more closely related to the type from Manitoba, Canada (Plate XVI), than it is to that from Alaska and Kreischerville (Plates XIV, XV).

Cliffwood Amber

The lignitic sands and clays at Cliffwood Bluff, New Jersey, on Raritan Bay were first included in the Raritan Formation, although they also have been referred to the Matawan Formation (Hollick, 1897; Berry, 1905a). However, the lignites, and amber-bearing beds in particular, were then considered to be in the Magothy Formation. Berry (1905a) states that "a secondary feature of the Magothy Formation is the occurrence of amber, which is found in the form of globular and tear-shaped drops, disseminated in the lignite beds from Cliffwood bluff, in New Jersey, southwesterly to the type amber locality of the coastal plain, at Cape Sable, Md." He indicates further that he has not found amber in pieces "larger than a lima bean, although occasionally one hears from the foreman of the clay pits of much larger masses having been found." Doyle (pers. comm., 1967) confirms the Magothy age of at least some of the Cliffwood lignites on the basis of his palynological studies.

Berry (1905a,b) studied the plant megafossils from Cliffwood and described various coniferous remains. Among the araucarians were *Dammara* and *Araucarites*. Penny (1947) also reported *Araucarioxylon* with tracheal pitting similar to modern species of *Agathis* and *Araucaria* here. Various species of *Pinus*, *Picea* and *Pitoxylon* are reported for the Pinaceae. Holden (1913) also listed *Pityoxylon* from this locality. In the Taxodiaceae, Berry reported various species of *Sequoia*, *Geinitzia* and *Cunninghamites*.

One spectrum (Smithsonian Collection with no number, collected by E.W. Berry from the Cliffwood Brick

Company) H 422 (Plate XVIII) is similar to that of the Magothy River type.

Martha's Vineyard Amber

Amber from Gay Head, Martha's Vineyard, Massachusetts, was collected by Clifford Kay, United States Geological Survey, Boston, Massachusetts. It had been reported previously from this locality by Finch (1824). Only a few small specimens have been found in a dark gray silt rich in fine plant debris, including seeds, cones, needles, leaf fragments and a variety of plant tissue excellently preserved (Kay, pers. comm., 1966). Unfortunately, these remains have not as yet been identified. Palynological evidence from these beds (J. Doyle, pers. comm., 1967) indicates their belonging to the Upper Raritan or Lower Magothy Formations.

The spectrum (H 111, Plate XXI) is quite distinctive from any of the other ambers from Cretaceous strata. The intensity of absorption in the carbon-oxygen single bond region ($8-10\mu$) may indicate a higher percentage of carbohydrates (as in a gum-resin). The presence of a distinct absorption peak at 11.3μ (885 cm^{-1}) is also notable.

Amber from Other Atlantic Coastal Plain Localities

Amber was obtained from six other localities along the Atlantic Coastal Plain. Stratigraphic data for these localities are unknown to the authors. It is assumed, however, that the amber most likely occurs in Raritan or Magothy beds.

Three spectra of "Ambrosine" from Charleston, South Carolina (USNM collection R7317), were made. The spectral type represented by H 210 (Plate XVII) is typical of that of Baltic Succinite (Beck *et al.*, 1964; 1966; Langenheim and Beck, 1965). Shepard (1870) suggested that this amber originated from conifers from

the "pleiocene epoch." Stratigraphic data are lacking, but Ambrosine has generally been considered from Cretaceous Atlantic Coastal Plain deposits (probably from the Tuscaloosa Formation, which does not differ greatly in age from the Magothy, according to Groot, Penny and Groot (1961)). Shepard described the original collection as an irregular, oval-shaped mass the size of a man's fist, yellow-brown externally but clove-brown inside. It melted to a clear yellow liquid at 460° F, giving considerable succinic acid before melting. On fusion, a dense yellow oil was volatilized, producing an odor similar to the resin of pines. It was largely soluble in turpentine, alcohol, ether and chloroform. The name "Ambrosine" was coined by compounding the two words "amber" and "rosin."

Three spectra were run from Kincora, Burlington County, New Jersey, from the United States National Museum Collection 5610. Spectrum H 367 (Plate XVII) is similar to that typical of the Magothy River family of ambers. A variation of this spectrum with a band developed at $12-12.3\mu$ ($833-813\text{ cm}^{-1}$) also occurs.

A single spectrum was made of amber from St. Georges, Delaware (USNM #82552). Spectrum H 357 (Plate XVIII) is generally similar to those from the Magothy River and Kincora, New Jersey, localities (Plate XVII). Three spectra were made of amber from Bordentown, N.J., (USGS collection #95367). All three were similar to that represented by H 225 (Plate XVIII), although the 9.8μ (1020 cm^{-1}) band is sometimes more accentuated. This spectral type also belongs to the Magothy River family.

Eleven spectra were made of amber from USNM collection R 7289 from Roebling, N.J. Considerable variation in spectra occurs from specimens in this single collection. The general variation is shown in spectra H

350, H 416, and H 420 (Plate XIX). All of this amber is opaque, with the color varying from light beige to streaks of almost black. The variation in the spectra appear to be due largely to intensity and resolution of the bands. Roebeling Type I resembles the Magothy River family of spectra.

Amber from Harrisonville, N.J. (Gloucester Co.) was reported by Kunz (1883). It was found from 20 to 28 feet under a green sand or marl containing invertebrate fossils which were considered "to belong to the middle bed of the Upper Cretaceous series." Kunz indicated that no analysis had been made of this amber, but he felt "the similarity in specific gravity, hardness and ignition leaves little doubt of its being true amber, or of its having been derived from a gum closely resembling that which is the source of the Baltic and other ambers."

The spectrum H 409 (Plate XX) disproves this relationship completely. The Harrisonville amber differs from almost all other fossil resins in that it lacks a well defined carbonyl group. Carbon-carbon unsaturation causes a sharp absorption band at 6.1μ (1650 cm^{-1}) of such intensity that the broader hydroxyl absorption in this region fails to obscure it. The distinctive pair of bands at 13.3μ and 14.3μ (750 cm^{-1} and 700 cm^{-1}) is clear evidence for the presence of mono-substituted benzenoid rings. This indicates a composition similar to that of the European fossil resin siegburgite which has been related to *Liquidambar* by chemical studies in which cinnamic acid and styrene were isolated (Klinger and Pitschki, 1884). These aromatic resins form a small but distinctive family of their own, which differ dramatically from the usual terpenoid resins which alone can be called "true amber."

The resin from Pemberton, N.J. (H 417, Plate XX) is of the same aromatic type as the Harrisonville sample

with the exception of lacking the broad intense band which obscures the region between 8 and 11μ (1250 and 990 cm^{-1}) in the Harrisonville sample. It also may well be due to inorganic impurities (silicates) which are characteristic of the European siegburgite.

Canadian Amber

Tyrrell (1890) investigated the occurrence of amber associated with fragments of decayed wood on the beach around the southwestern margin of Cedar Lake, near the mouth of the Saskatchewan River, Manitoba, Canada. He reported abundant amber along the beach for a mile, in a band thirty feet wide with a minimum depth of two feet. He further estimated that this deposit contained 1,437,280 (!) pounds of amber. He also discovered amber occurring less extensively on shores of other lakes north and east of Cedar Lake. Because the amber has been deposited secondarily, the geologic age is uncertain. As Carpenter *et al.* (1938) indicated, however, Cedar Lake is fed by an easterly flowing river that drains through lignitic beds of late Cretaceous age in Alberta and south Saskatchewan. Thus, other amber-bearing deposits from which Cedar Lake amber could have originated are not evident. Carpenter *et al.* point out that the insect inclusions also provide support for a Cretaceous age. Evidence for a more specific time during the long Cretaceous interval, however, is not available.

Although it cannot be definitely related to the Cedar Lake deposits, amber with insects found recently at Medicine Hat, Alberta (Richards, 1966), is of some interest in regard to the Manitoban material. The Medicine Hat amber is associated with lignitic deposits from the Foremost Formation (Belly River Series, Upper Cretaceous). The Belly River Series falls within the Campanian Stage, as K/Ar dates for the Bearpaw shales

that occur immediately above the Foremost horizons at Medicine Hat range from 72 to 73 million years. None of this amber has as yet been available for analysis.

Amber collected by Tyrrell was studied by Harrington (1891) and named chemawinite. Klebs (1896), apparently unaware that Harrington had described it, analyzed the same type of amber from Cedar Lake and called it cedarite. Schmid (1930), in his review of fossil resins, classifies them as (a) “*Bernstein* which yields succinic acid on distillation, the principal type being succinite, (b) those resembling *Bernstein*, including cedarite, and (c) those quite different from (*fern stehende*) *Bernstein*, including chemawinite.” Walker has already pointed out, “the two Canadian minerals, cedarite and chemawinite, are identical, as appears probable both from the chemical and physical data recorded by Harrington and Klebs, and from the localities from which the material was obtained.” Harrington (1891) made the most complete chemical analysis of this amber. The hardness was 2.5; the specific gravity 1.055 at 20° C. The mean percentages of constituents from elemental analyses were: C, 79.96% ; H, 10.46% ; O, 9.49% and ash 0.9%. The ash contained silica, alumina, iron, calcium and magnesium. 20.01% of the amber dissolved in absolute alcohol and 24.84% in absolute ether. Small fragments heated in a closed tube began to soften at about 150° C. Heated to 300° C, the resin did not melt into a flowing liquid but had become soft and elastic and darkened from partial decomposition. Harrington concluded that this Canadian amber was more resistant to heat than Baltic amber. Succinic acid, so characteristic of Baltic amber (Succinite), is absent. These facts, in addition to the presence of more carbon and less oxygen than Baltic Succinite, led him to conclude that the Canadian amber “is closer to Walchowite and to some of the more recent copals from India.”

This Canadian amber is transparent, varying from pale yellow, red to dark amber in color. Walker (1934) reported that the smallness of the amber grains (58% being less than eight mesh and only 3% larger than two mesh) was a point of difference from that of the generally larger masses characteristic of Baltic amber. He suggested that this might indicate conifers of types yielding little resin when wounded, in contrast to those which produced resin copiously in the Baltic forests.

Eleven spectra were run on amber from Cedar Lake. Ten of these spectra were of specimens from the Harvard University Entomological Collections. All of these gave the same pattern represented by H 316 (Plate XVI), although some spectra were sharper than others. Also the pattern of amber from Cedar Lake, Manitoba, is similar to Ambrite (H 226, Plate XVI) from New Zealand (USNM #7312). Both of these spectra, in turn, are similar to resin from *Agathis australis*, the Kauri pine (H 265, Plate XVI). Since *A. australis* is noted for its capacity to produce large quantities of resin, it is a logical source for fossilized resin from New Zealand. A possible Araucarian source, such as *Agathis* or related araucarians, for this Canadian amber is interesting and suggestive. More resins of members of the Araucariaceae need to be analyzed, before a definite correlation is made. Also the possible presence of *Agathis australis* (called *Dammara australis* Lamb.) in the Kreischerville, N.Y., deposits is noteworthy. Certainly, in the Potomac (Albian), Raritan (Cenomanian-Turonian) and Magothy (Early Cenomanian) Formations along the Atlantic Coastal Plain, members of the Araucariaceae were common, and an araucarian-type resin could well be expected. Araucarian leaf remains, i.e., *Araucarites longifolia*, are reported from Upper Cretaceous beds in the Rocky Mountains (Lance) by Dorf (1942), although

remains similar to *Agathis* have not been listed.

One Cedar Lake specimen (USNM #97080) gave a spectrum similar to that of Baltic Succinite (Langenheim and Beck, 1965). The presence of this spectral type might suggest two different botanical sources of the amber from the Manitoban deposit.

Baja California Amber

Buddhue (1935) described "Bacalite" as amber presumably from Baja California, Mexico. Since this amber cannot be shown to have come from Baja California, Langenheim, Buddhue and Jelinek (1965) recognized that "it may have come from any place in the world." They mention, however, the particular likelihood of its being from the amber deposits of Chiapas, Mexico.

Hurd, Smith and Durham (1962) reported documented occurrences of amber from Baja California, based on the discovery by A.C. Allison and F.H. Kelmer. Langenheim, Buddhue and Jelinek (1965) further elaborated on the age and occurrence of this amber. It has been observed at three localities between Punta San José and Punta Cabras. At each locality, a single nodule of amber from 1½–2 inches in diameter was collected from siltstone or sandstone thought to be latest Campanian or earliest Maestrichtian in age. At Punta Baja, about 10 miles southwest of El Rosario, small fragments of amber occur in sandstone with carbonized leaf impressions. *Metaplefenticiras pacificum* Smith occurs in the same bed and indicates late Campanian age. Small grains of amber and carbonized wood were also reported from a sandstone interbedded with a claystone south of the mouth of Arroyo Rosario.

Four spectra were run from a single collection (University of California, Museum of Paleontology, B-3006) from the Punta San José locality. The material generally

is opaque, varying in color from beige to molasses to almost black. More variation occurred in the spectra from these few pieces than is frequently the case where a larger number of samples have been run, i.e., from Chiapas, Mexico and Alaska. Three spectra showing this variation are presented in Plate XXII. Type I (H 45) and Type II (H 320) are similar, but Type III differs in having a broader and more intense absorption band between $9-10\mu$ ($1110-1000\text{ cm}^{-1}$). This may be due to inclusions of siliceous material. Type III was taken from a light beige portion of a banded specimen of which Type II represents the darker portions. As indicated with the Roebeling, N.J. amber, more heterogeneity must be expected in the opaque amber types than in the transparent ones.

EARLY TERTIARY AMBER

Amber is reported to occur in strata from early Tertiary time (Eocene to Miocene) in various areas throughout North and South America. A fairly extensive deposit has been discovered in Chiapas, Mexico, and is being intensively investigated by geologists, entomologists and botanists. Thus, the Chiapas deposit can serve as a useful standard for comparison of other Tertiary ambers as the Alaskan deposit does for Cretaceous ambers. Small amounts of Eo-Oligocene amber occur near Seattle, Washington; amber of probable Oligocene age occurs in the Dominican Republic and of Miocene age in Pará, Brazil. The age of amber from several other localities probably is early Tertiary, but stratigraphic data are lacking.

Chiapas Amber

Amber from Chiapas, the southernmost state in Mexico, has been reported in mineralogical studies (Helm, 1891; Kunz, 1903; Tschirch, 1906; Hintze, 1933;

Buddhue, 1935; Tschirch and Stock, 1936), but it has neither been analyzed chemically and physically nor been given a mineralogical name. The geologic occurrence was first recorded by Böse in 1905. A coordinated scientific investigation was initiated by entomologists and later included geologists and botanists (Hurd and Smith, 1957; Hurd, Smith and Durham, 1962; Langenheim, 1964, 1966, 1967; Langenheim, Hackner, and Bartlett, 1967).

The amber-bearing beds are in a sequence of primarily marine, calcareous sandstones and siltstones which are mostly exposed in landslides. All amber-bearing localities are considered latest Oligocene to earliest Miocene in age, based on marine invertebrate fossils (Licari, 1960; Hurd, Smith and Durham, 1962). Pollen from the strata either containing the amber or immediately adjacent to them indicates development of mangrove vegetation of considerable complexity at or close to the site of deposition of the amber (Langenheim, Hackner and Bartlett, 1967).

Previous discussions have presented evidence supporting the conclusion that this amber was derived from the leguminous genus *Hymenaea* (Langenheim, 1963; Langenheim and Beck, 1965; Langenheim, 1966; and Langenheim, 1967). Spectra were made of various resins from populations existing in Chiapas today. Each genus, as well as certain species populations, was clearly distinguishable. Remarkably consistent spectra were obtained from 35 samples of *Hymenaea Courbaril* L. from various populations in Mexico, Guatemala, Dominica, Costa Rica, Guyana, Venezuela, Brazil and Ecuador. Forty specimens of Chiapas amber from the University of California, Museum of Paleontology Collections from various localities were chosen for spectra because they showed some difference in physical character. The color

of this amber varies from yellow, golden brown, red to black; the most common being the yellow and golden brown hues. Variety in appearance tended to indicate that several kinds of trees might have produced the amber. All but two specimens fit into two spectral patterns indicated as Type I (H 1A) and Type II (H 88), Plate XXIII. A third type (H 1C) gives an ill defined spectrum. It was, therefore, initially assumed that these three patterns might indicate three different sources (Langenheim, 1963). The two major types (14 samples of each), however, are similar to each other, except for the more general flattening of the bands and loss of the sharp band at $11.2\text{--}11.3\mu$ ($895\text{--}885\text{ cm}^{-1}$) in Type II. The similarity is now thought to be sufficient to suggest that both Type I and Type II were derived from the same source and that the differences may be explained by additional atmospheric oxidation and progressive polymerization. The two specimens representing Type III (H 1C, Plate XXIII) are black in general appearance, although small pieces show a ruby red color in transmitted light. The pieces are extremely soft and friable, indicating that they had been partially decomposed. Type I had a spectrum similar to that of *Hymenaea Courbaril* (H 1B-IV, H 58, Plate XXVII), although there are some differences. Langenheim and Beck (1965) explained that the broad band at $14.2\text{--}14.4\mu$ ($705\text{--}700\text{ cm}^{-1}$) due to unassigned skeletal vibration has disappeared in the amber. The 11.3μ (885 cm^{-1}) band which can be assigned to $=\text{CH}_2$ out-of-plane deformation of terminal carbon-carbon bonds decreases, as would be an expected result of progressive oxidation by atmospheric oxygen. The attendant formation of new carbon-oxygen bonds would also account for the slight shift of absorption maximum near 8μ (1250 cm^{-1}) which is more often at 7.6μ (1295 cm^{-1}) in the *Hymenaea* resin but more often at 8.1μ (1235 cm^{-1})

in the amber. It is also significant that none of the other resin producers in Chiapas today had spectra resembling the amber (Langenheim and Beck, 1965). Thus, the infrared spectra have given convincing evidence that the Chiapas amber was derived from an ancestral member of *Hymenaea*.

The presence of *Hymenaea* leaflets in the amber provides further corroboration for the source (Langenheim, 1966). This conclusion receives additional support from studies of the manner of resin production and accumulation in *Hymenaea Courbaril* (Langenheim, 1967) and the depositional conditions of the amber. *H. Courbaril* produces large quantities of resin that accumulate in the soil around the roots, and in Mexico today it grows commonly along rivers that enter the ocean in mangrove-fringed estuaries. Analysis of the pollen in the amber-bearing beds indicates that the amber was deposited in such an estuarine environment with abundant mangrove present (Langenheim, Hackner and Bartlett, 1967).

Seattle Amber

Amber from the Renton Formation near Seattle, Washington, was discovered by J. Wolfe. Vine (1962) considers the Renton to be late Eocene to early Oligocene in age. Wolfe (pers. com., 1966) reports that there are no plant fossils at the amber locality itself, although they are common in the Puget Group, of which the Renton Formation is a member. Conifers present are taxodiaceous, including *Sequoia*, *Metasequoia* and *Glyptostrobus*. The dicotyledenous flora is rich but still largely unidentified. The La Porte and Comstock floras are about the same age as the Renton.

Five spectra were run of amber from the Museum of Paleontology, University of California Collection B8427. Most of this amber occurs in small friable pieces. It is

pale yellow and transparent. Chemical and physical analyses have not been made. There was some variation in the spectral patterns (Plate XXIV) as indicated in Type I and Type II (Spectra H 323 and H 42A). These spectral types from Seattle are similar to those of Types I and II from Baja California (Plates XXII and XXIV) which indicates possibly that they may be from the same source. There are no present suggestions for the botanic source from these two localities either from associated plant remains or from spectra of modern resins.

Dominican Republic Amber

Sanderson and Farr (1960) state that amber was first reported from what now is the Dominican Republic by Christopher Columbus during his second voyage to the West Indies between 1494 and 1496. No further reference to Dominican amber during the next 400 years appears to have been recorded. In 1905, Sample described an amber-bearing formation in the Monte Cristi Range (Cordillera Septentrional). Lengweiler (1939) then reported that fragments of lignite, leaves, and insects, such as mosquitos and ants, were found in the amber.

Sanderson and Farr (1960) indicate that the amber-bearing formation in the Dominican Republic are located at two principal sites in the Cordillera Septentrional north of Santiago between Altamira and Conca. The original site is the Pena (Tamboril) region in the two gorges of the Arroyo Capancho tributary of the Rio Gurado. The second site is below Pico Diego de Ocampo in the Palo Alto de la Cumbre region. Sanderson and Farr collected the amber in a light brown-dark grey, fine-grained, micaceous sandstone occurring below a silty shale at this second site. Brower (Sanderson and Farr, 1960) believes this amber to be Oligocene in age, although the exact date remains in doubt. The amber

occurs irregularly as small broken fragments to large unbroken pieces. Transparent, unfractured pieces are common, but many small broken pieces are brittle and fracture. The color varies from clear crystal through various amber-shades to deep red. Chemical or physical analyses have not been made of this amber.

Six spectra were made of amber from the Dominican Republic. Type I (H 37) is from a specimen from the Palo Alto de la Cumbre site collected by Sanderson (Plate XXV). Three others from an unidentified locality near Santiago gave a pattern similar to this one from the known site. Two were run of specimens from USNM collection #R6783, from Palo Quemado, Santiago Province, Santo Domingo. These samples gave a more generalized spectrum as represented by (H 427) than the other four (Plate XXV). They are designated as spectral Type II, and represent probably more oxidized specimens as indicated by the almost complete loss of the 11.3μ (885 cm^{-1}) band. The spectral pattern is unique for North and South American ambers examined thus far. No extant groups have given a pattern similar to this, and, with correlative paleobotanical data lacking, there presently is no hint as to botanical source.

Brazilian Amber

A single piece of amber has been collected from the Pirabas Formation near Capanêma, Pará, Brazil. This formation is considered early Miocene in age and is accompanied by numerous dicotyledenous leaves (Lelia Duarte, pers. com., 1966). Spectrum H 452 is closely similar to resin from extant *Hymenaea Courbaril* (Plate XXVIII), especially from Brazil (H 61) and Costa Rica (H 252). *Hymenaea* thus appears to have been the source of this amber as well as that from Chiapas, Mexico. Perhaps future paleobotanical studies on these beds will give additional supporting evidence.

AMBER OF UNKNOWN AGE

The geologic age and paleobotanic information are not available for a number of amber collections. These collections are being presented separately, although they will be related to ambers of known age wherever this appears justifiable.

Greenland Amber

Two spectra were made of amber from Hare Island in Greenland from a collection from Museum für Naturkunde, Berlin. The amber occurred as droplets in coal. The spectrum (H 165) is poorly developed, due probably to oxidation (Plate XV). This amber is assumed to be Cretaceous, because of the extensive, well known Cretaceous plant fossil localities in this area of Greenland, although there is no direct confirmation of this age.

Montana Amber

Nine spectra were run of the amber from Montana. Collections were available from the United States National Museum and the New York Museum of Natural History. No geologic age is indicated for this amber. Four spectra were made from the USNM Collection #112822, listed only from "Montana." They are represented by the Type I pattern represented by H 404 (Plate XX). This is the third example of the aromatic series described above from Pemberton, N.J. (H 417) and Harrisonville, N.J. (H 409). The Montana sample is virtually indistinguishable from that from Pemberton. Both lack the broad absorption band of the Harrisonville sample between 9 and 10μ ($1110-1000\text{ cm}^{-1}$) which we have assigned to silicate impurities.

Five spectra were run from the N.Y. Museum of Natural History collection #18395, listed from Washoe, Montana. Four spectra gave the pattern of Type II

(H 405) and one gives Type III (H 425) shown in Plate XXI. The small differences between these two types may be due to oxidation and progressive polymerization. Both are similar to the Magothy River family.

Cañon Diablo, Arizona Amber

One spectrum (H 365) of amber was run from USNM collection #62993 (Plate XXIV). The age of this sample is unknown; in fact, no data are available for it. The spectrum is somewhat like those belonging to the Atlantic Coastal Plain Magothy family of ambers.

Ecuadorian Amber

Amber from a "large deposit" near Guayaquil, Ecuador, was reported by Johnston (1838) and named Guayaquillite. No geologic age was given. Two kinds, a light yellow, almost homogeneous material and a dark brown, bituminous-like substance, were found. The "pure" mineral is opaque, powders easily, and is soluble in alcohol. The specific gravity is 1.092 and the melting point between 157°–212° C.

Three spectra were made from USNM collection #R7328. Spectrum (H 212) is typical for the three (Plate XXV). Frondell (1967) has shown that X-ray diffraction patterns of Guayaquillite are similar to those of a sample of various species of *Protium*, a genus in the Burseraceae. Some infrared spectra of *Protium Icicariba* suggest the same relationship, whereas other species of *Protium* differ significantly.

Colombian Amber

We have examined amber from two localities in Colombia. Boussingault (1843) reported amber to have been found in large amounts in a gold-bearing alluvium at Girón, near Bucaramanga, Departamento de Santander

del Norte. From the locality, this amber has been named Bucaramangite. Since it was found in alluvium, it might have been transported some distance from beds of any age. The sample analyzed came from a pale yellow transparent piece that weighed 12 kg. It is insoluble in alcohol, swells and becomes opaque in ether and does not contain succinic acid.

Four spectra were run from USNM collection #R7317. Three spectra (Plate XXVI) were similar to Type I (H 429). Another spectrum was like Type II (H 208) which had a better resolved version of Type I.

Cockerell (1923) reports two species of *Diptera* in amber from the Valle de Jesús in the Departamento de Santander del Sur. He characterized it only as being "relatively soft" and of "uncertain age."

Amber from Medellín, Colombia, is also available from USNM collection #97466. Although it is listed as "copalite," we are unaware that its geologic age or its chemical or physical description have been published. Six spectra were run and H 359 (Plate XXVI) is representative of them.

The spectra represented by H 208 (Girón) and H 359 (Medellín) can be related generally to spectra of *Hymenaea Courbaril*, just as in the case of amber from Chiapas, Mexico. In previous discussions of Chiapas amber (Langenheim and Beck, 1965; Langenheim, 1966; Langenheim, 1967), spectra of resin from modern populations of *Hymenaea Courbaril* were compared from Mexico, Guatemala, British Guiana (Guyana), Brazil, Venezuela, and Ecuador. Considerable similarity in the spectra throughout the wide distribution of this population was noted, although certain populations were more similar than others. For example, spectra of the Chiapas amber resembled more closely the spectra of *Hymenaea* resin from populations in Mexico and Guatemala than

those with a more southern distribution. Therefore, it was not surprising when the spectra of amber from Girón and Medellín, Colombia, compared closely with *H. Courbaril* resin from Guyana and Brazil (Plate XXVII). We presently do not have specimens of *H. Courbaril* from Colombia.

These spectra of Colombian amber seem sufficiently close to present-day *Hymenaea* to indicate its possible botanic origin. Unfortunately, we do not know the geologic age nor have corroborative evidence for the botanic source from plants included in the amber or in the amber-bearing beds, such as was available for the amber from Chiapas, Mexico.

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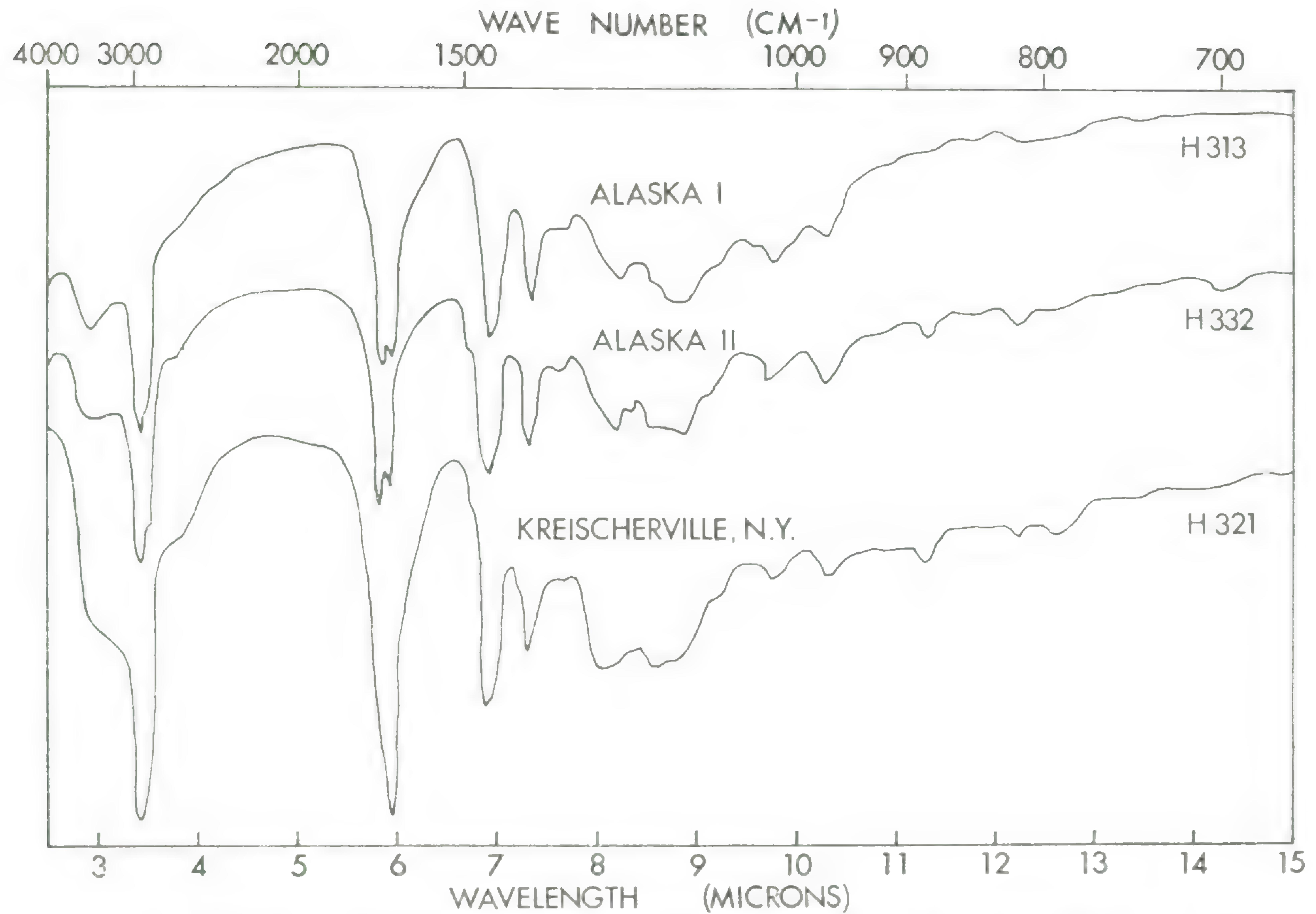
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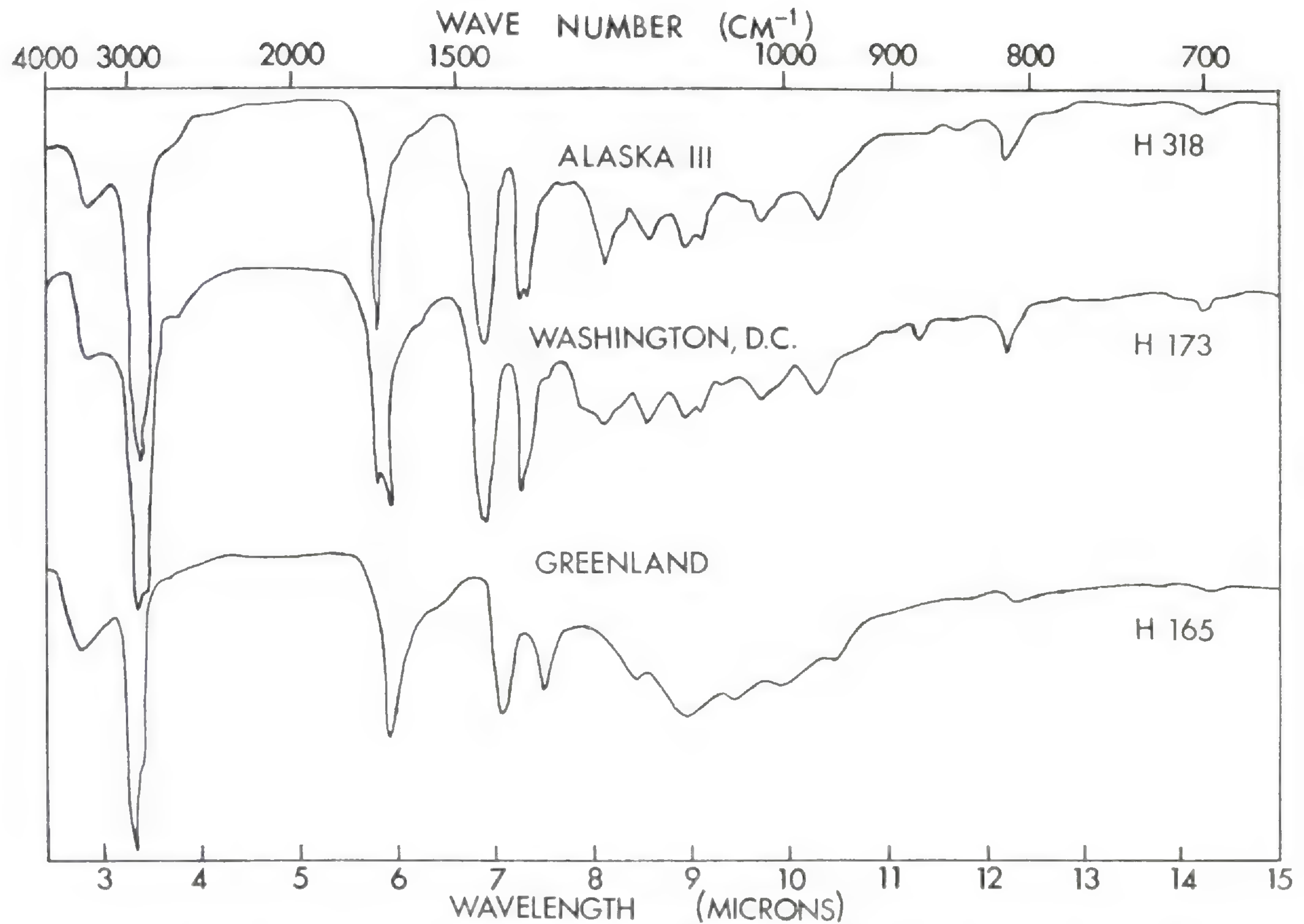
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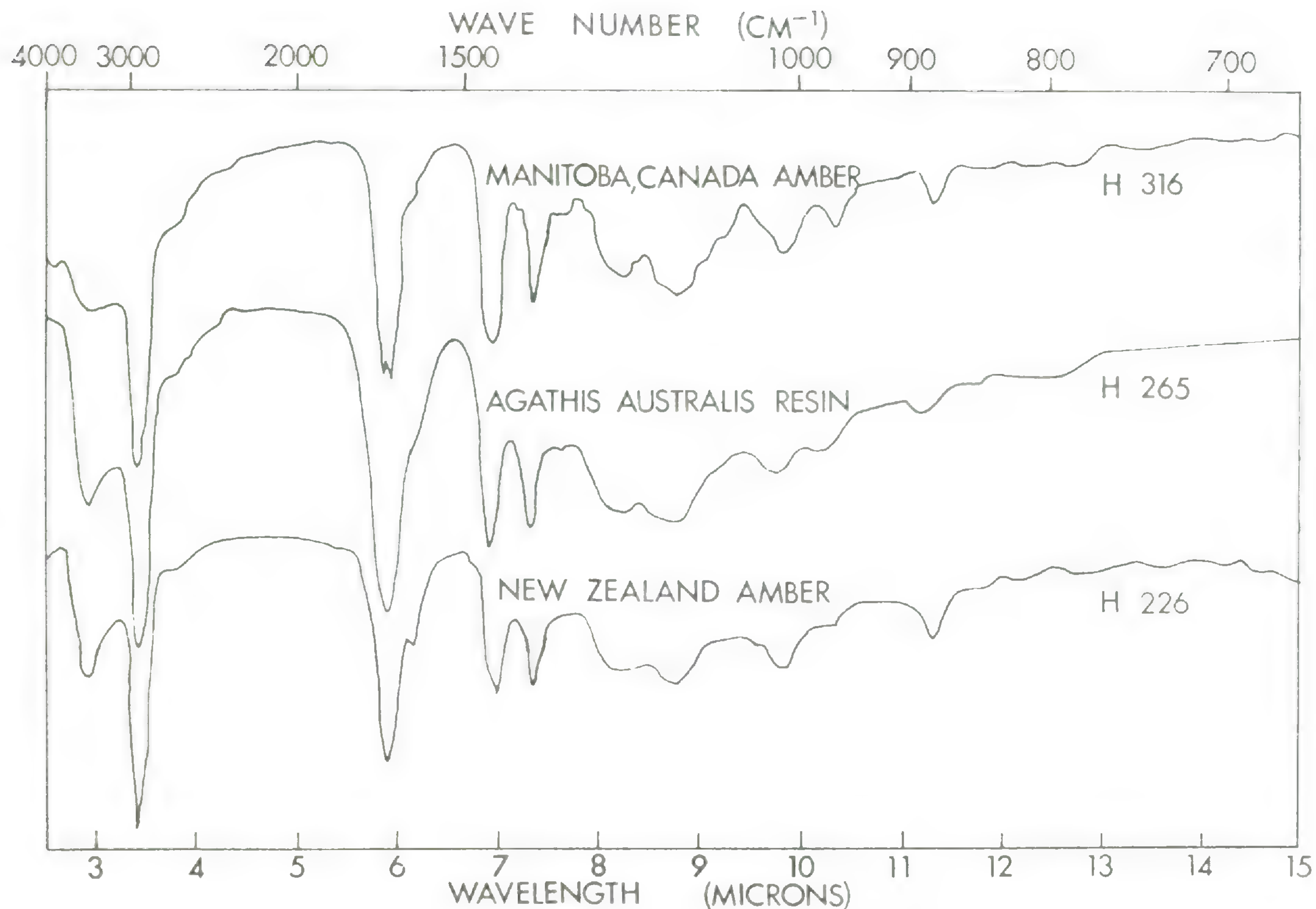
Infrared spectra of Cretaceous amber from Alaska Types I and II and Kreischerville, N.Y.

[107]



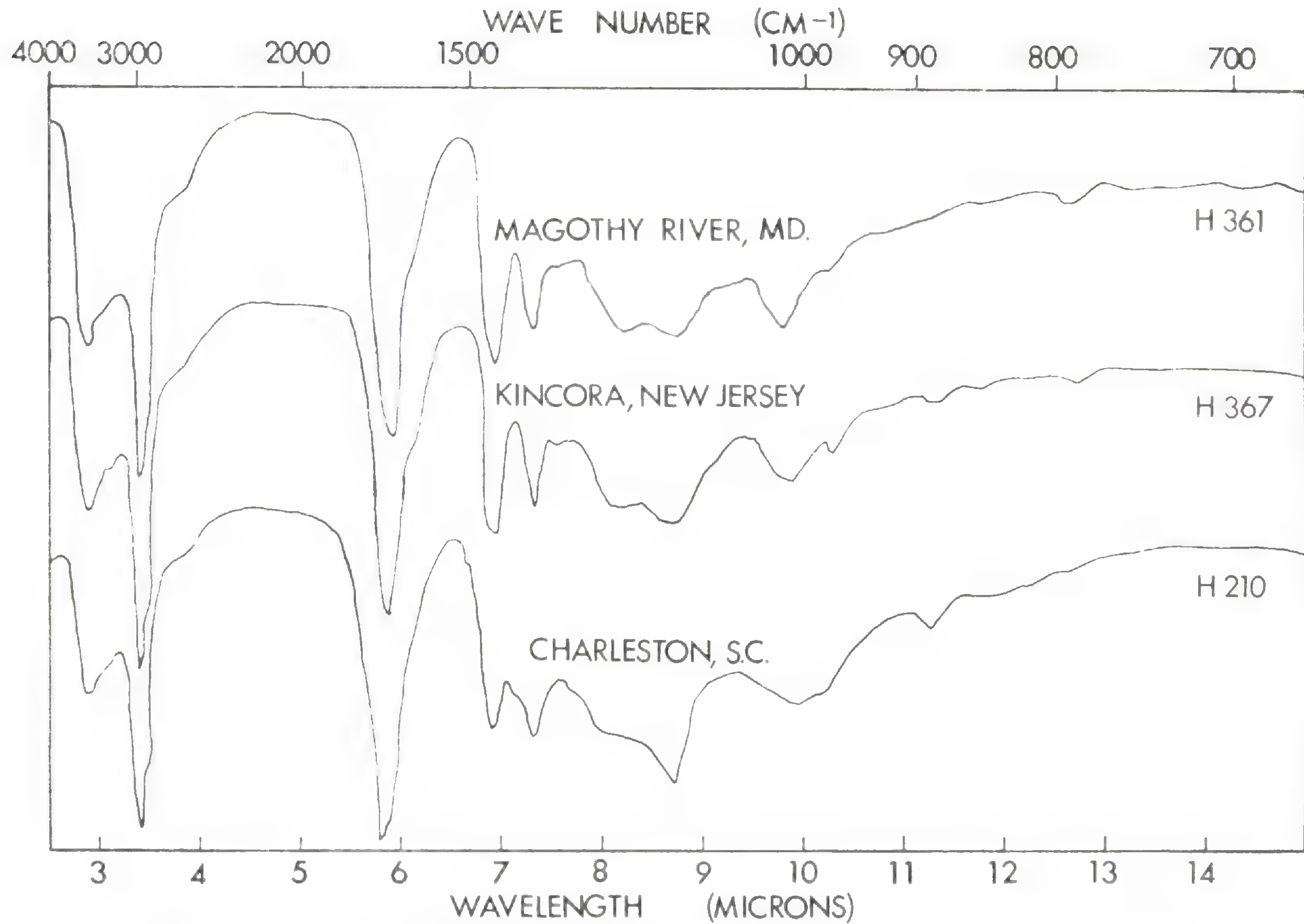
Infrared spectra of Cretaceous amber from Alaska Type III, from Washington, D.C. and of unknown age from Greenland.

[108]

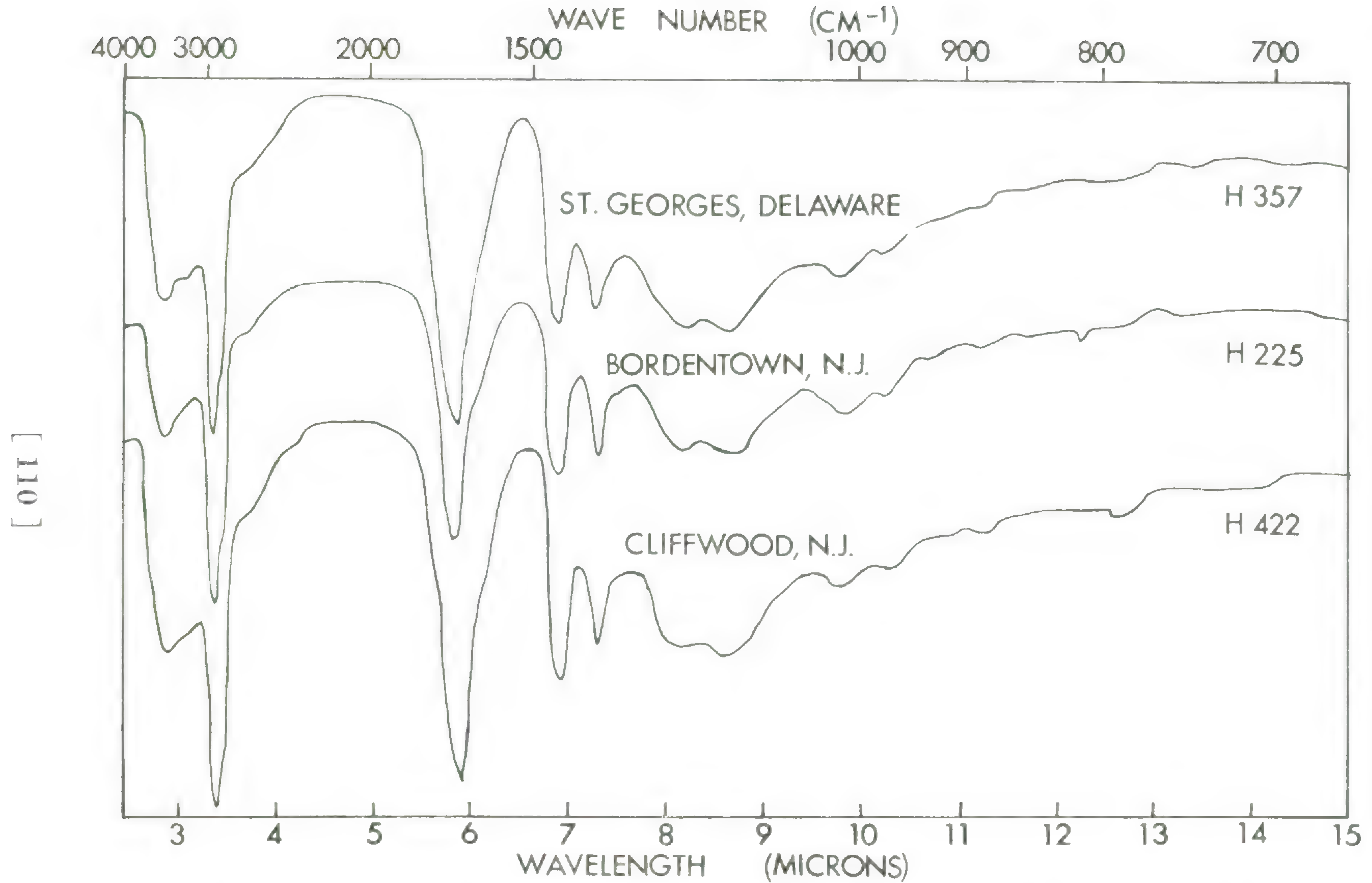


Infrared spectra of Cretaceous amber from Manitoba, Canada, Pleistocene amber from New Zealand, and of modern resin from *Agathis australis*.

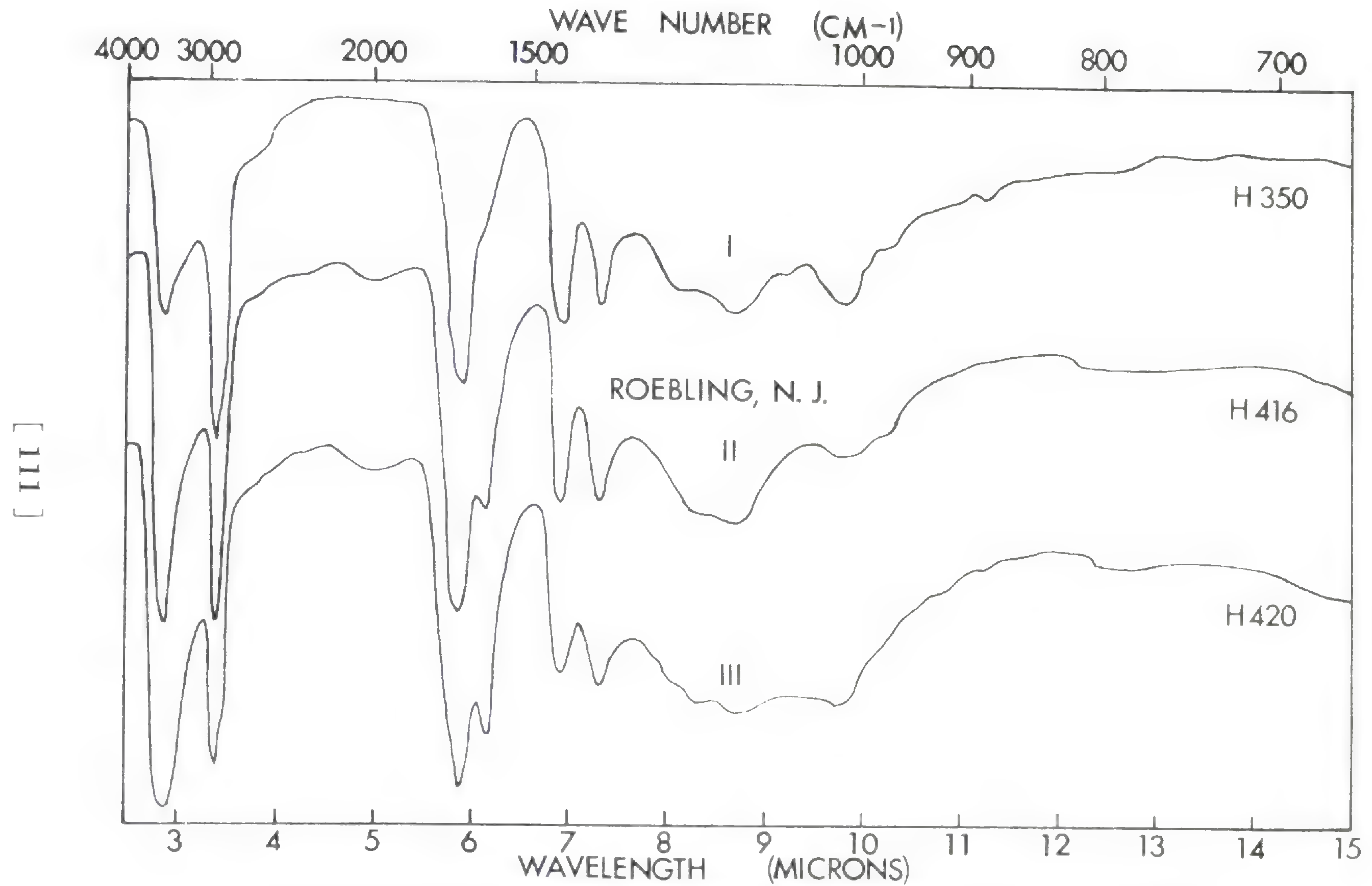
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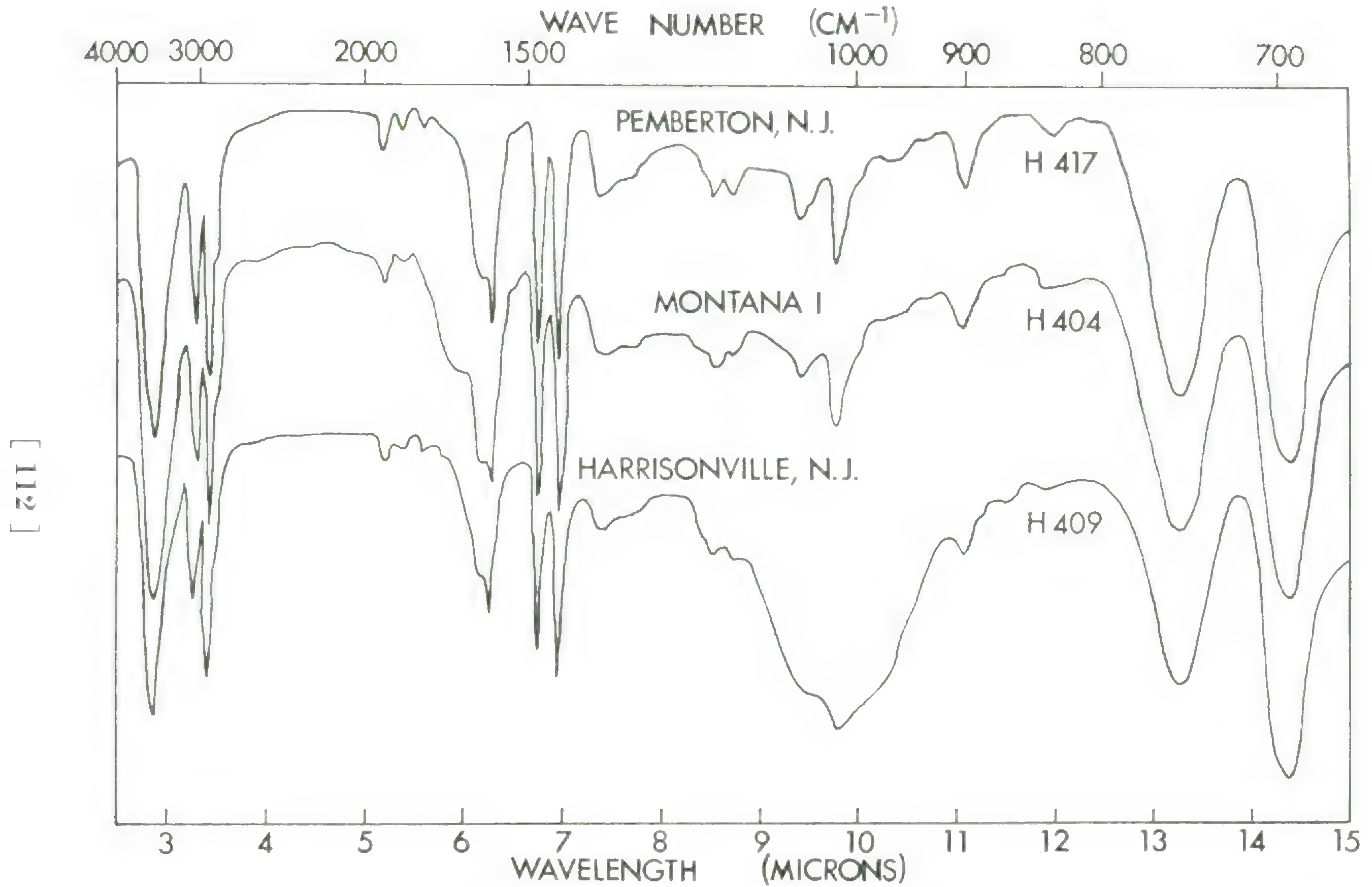
Infrared spectra of Cretaceous amber from Magothy River, Maryland; Kincora, N.J.; and Charleston, S.C.



Infrared spectra of Cretaceous amber from St. Georges, Delaware; Bordentown, N.J.; and Cliffwood, N.J.



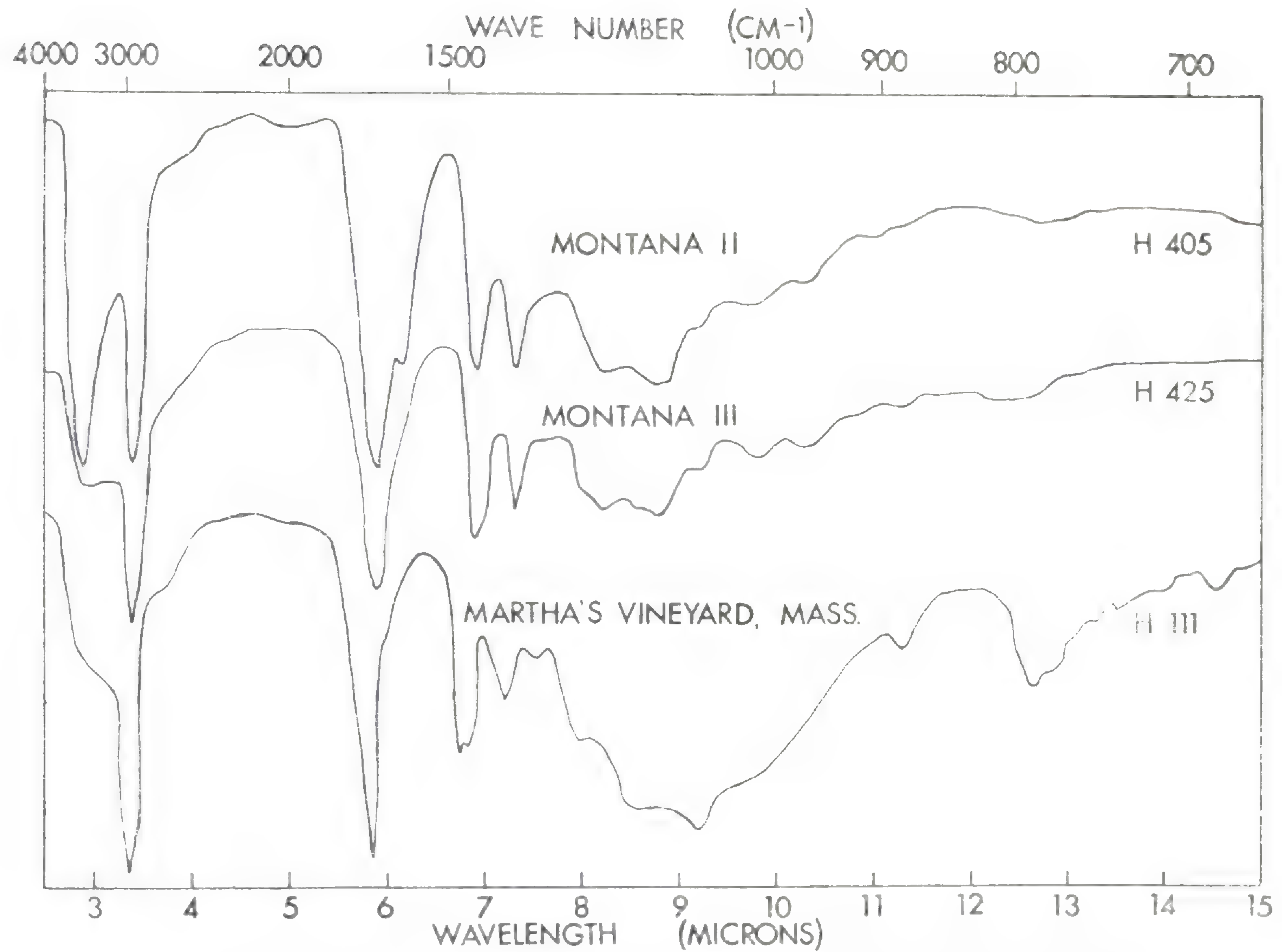
Infrared spectra of Cretaceous amber from Roebling, N.J. Types I, II and III.



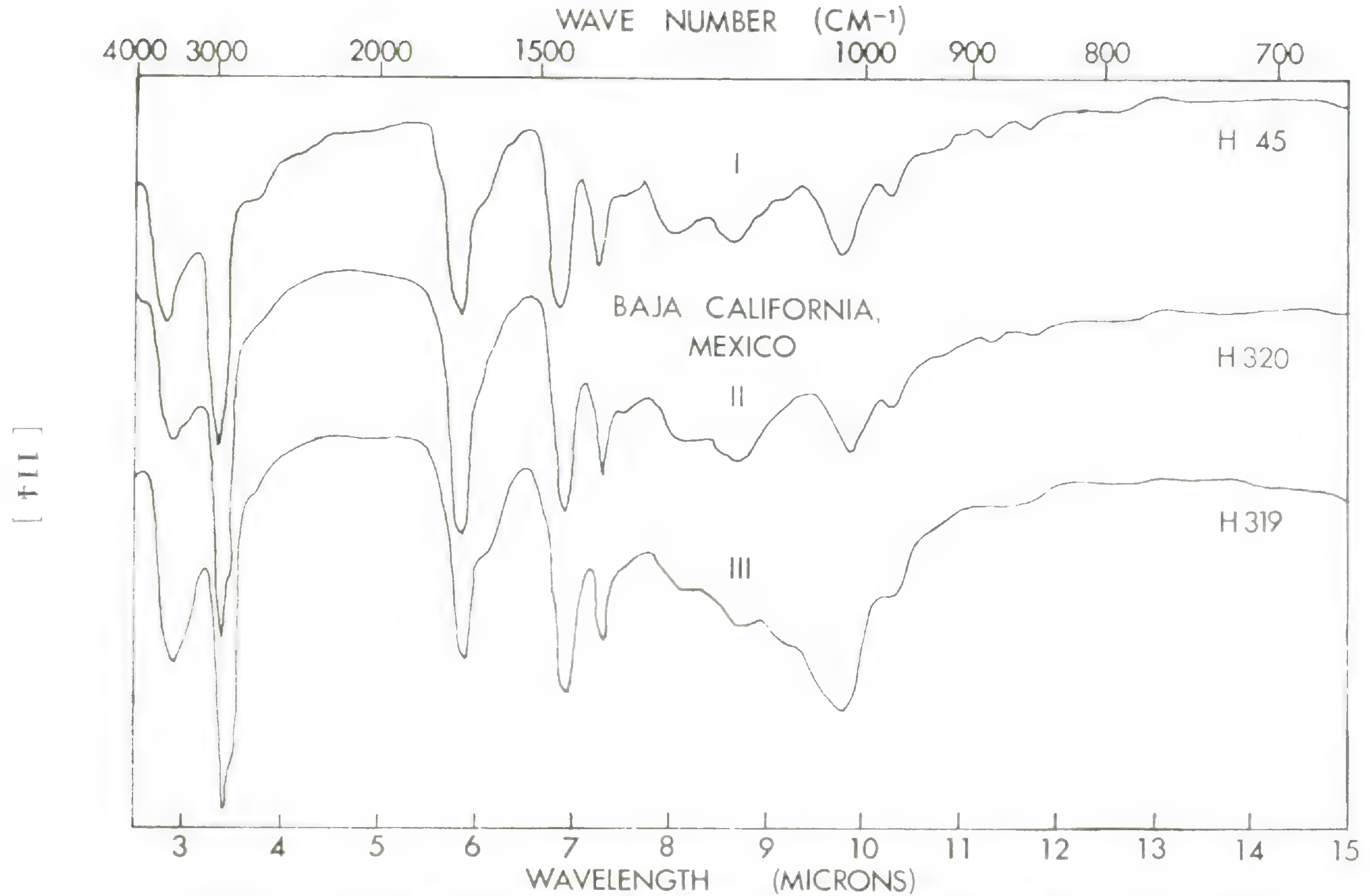
[112]

Infrared spectra of Cretaceous amber from Pemberton, N.J. and Harrisonville, N.J. and unknown age from Montana Type I.

[113]

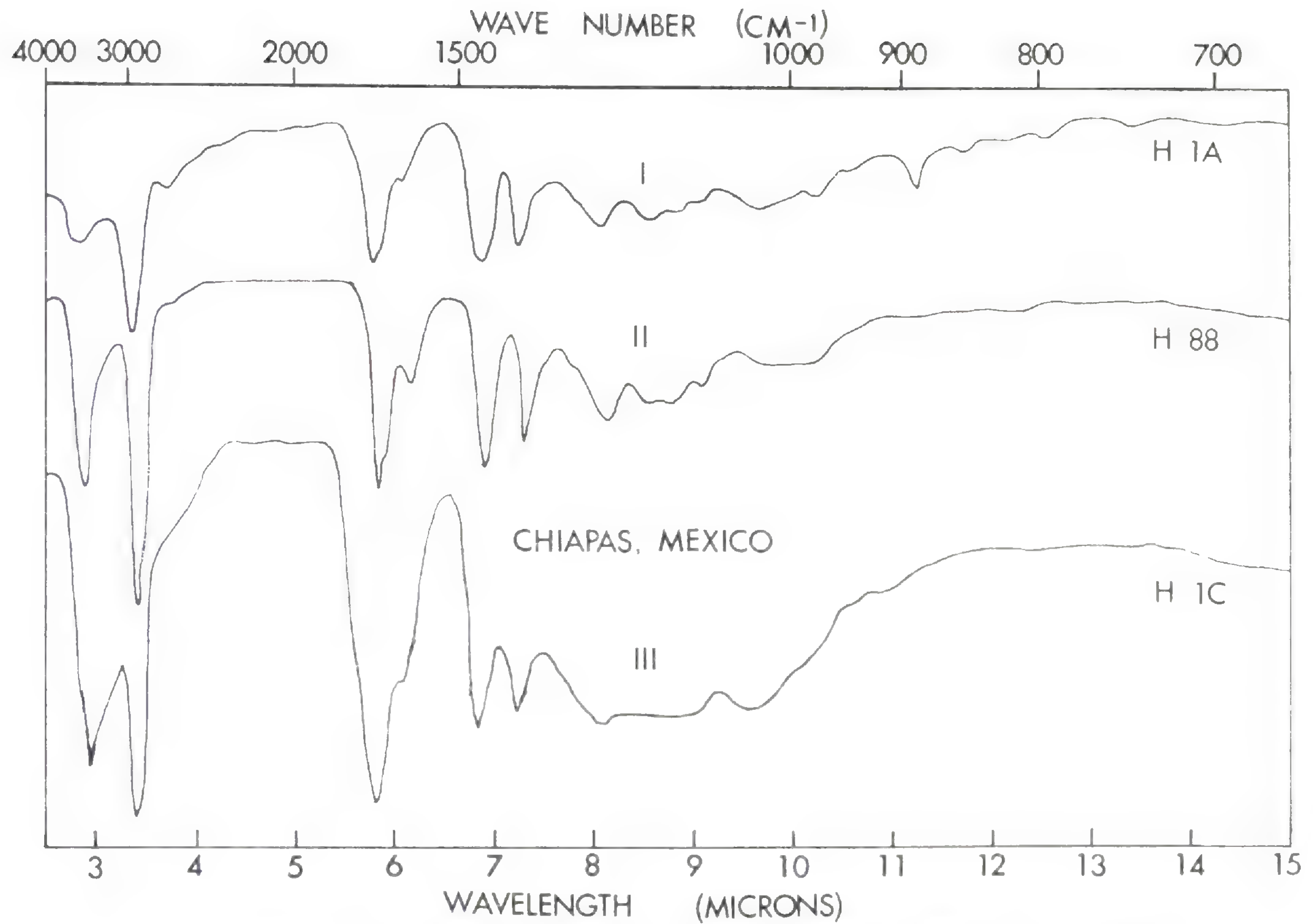


Infrared spectra of amber of unknown age from Montana Types II and III and Cretaceous amber from Martha's Vineyard, Mass.



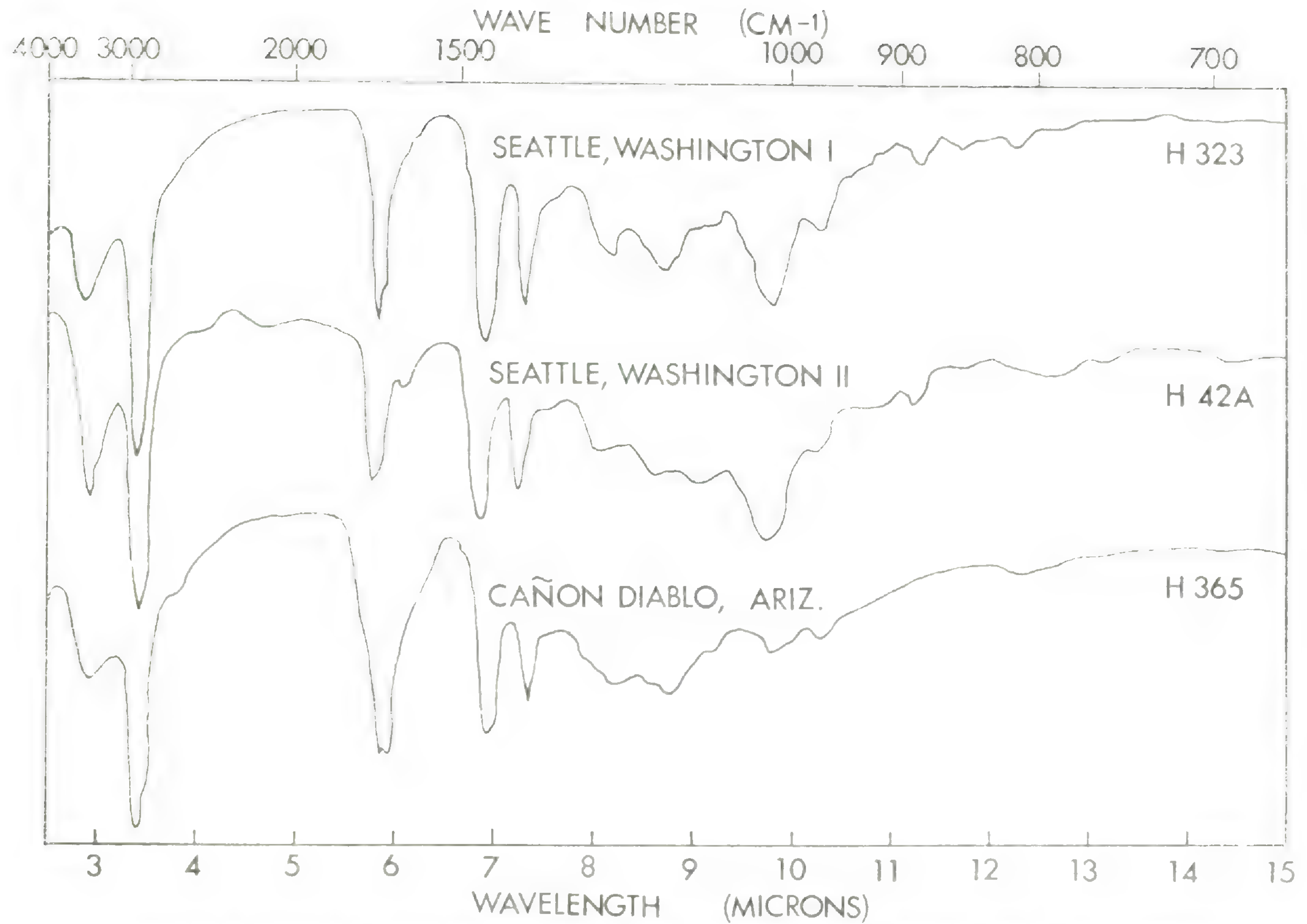
Infrared spectra of Cretaceous amber from Baja, California, Mexico, Types I, II and III.

[115]



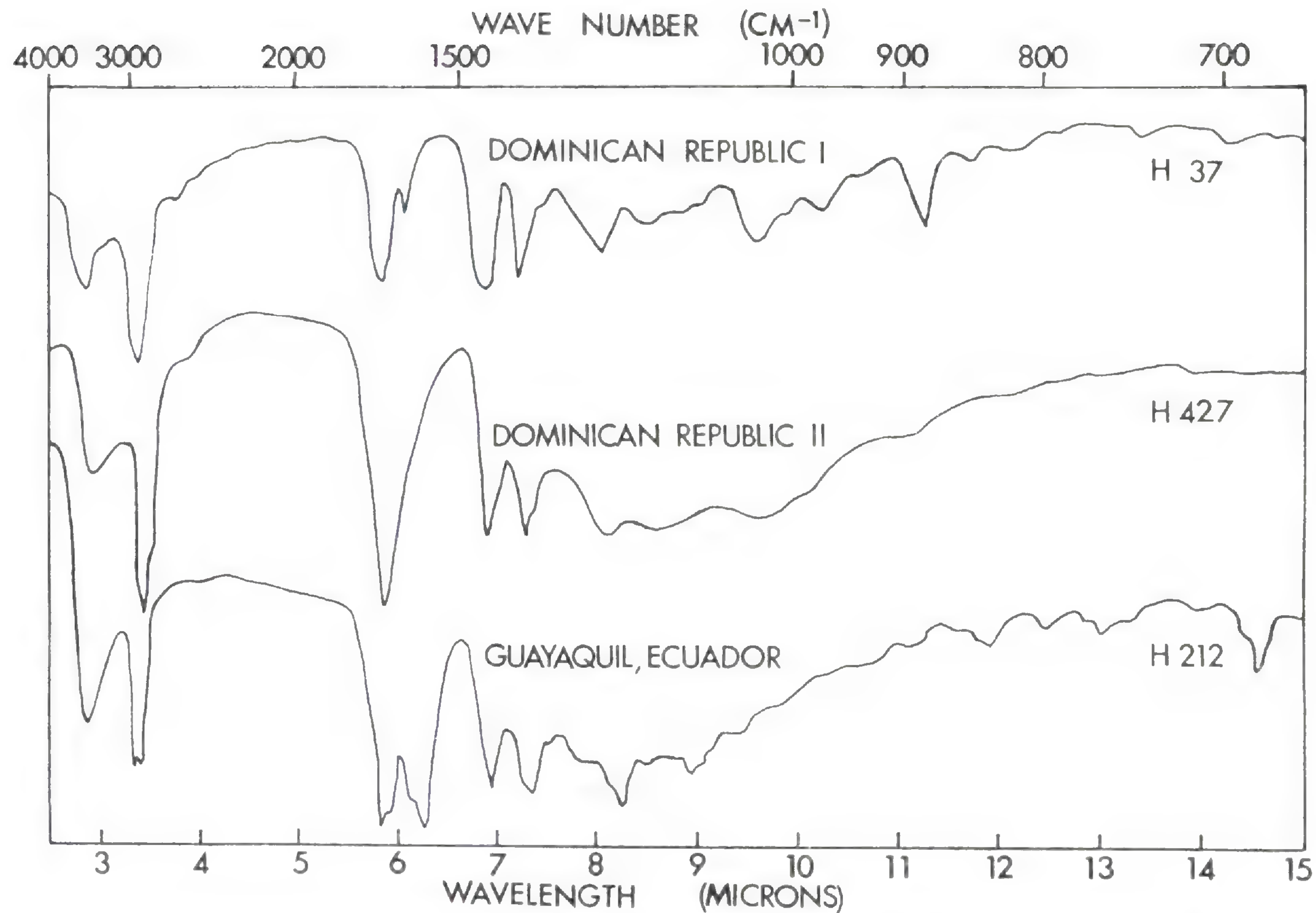
Infrared spectra of Oligo-Miocene amber from Chiapas, Mexico, Types I, II and III.

[116]



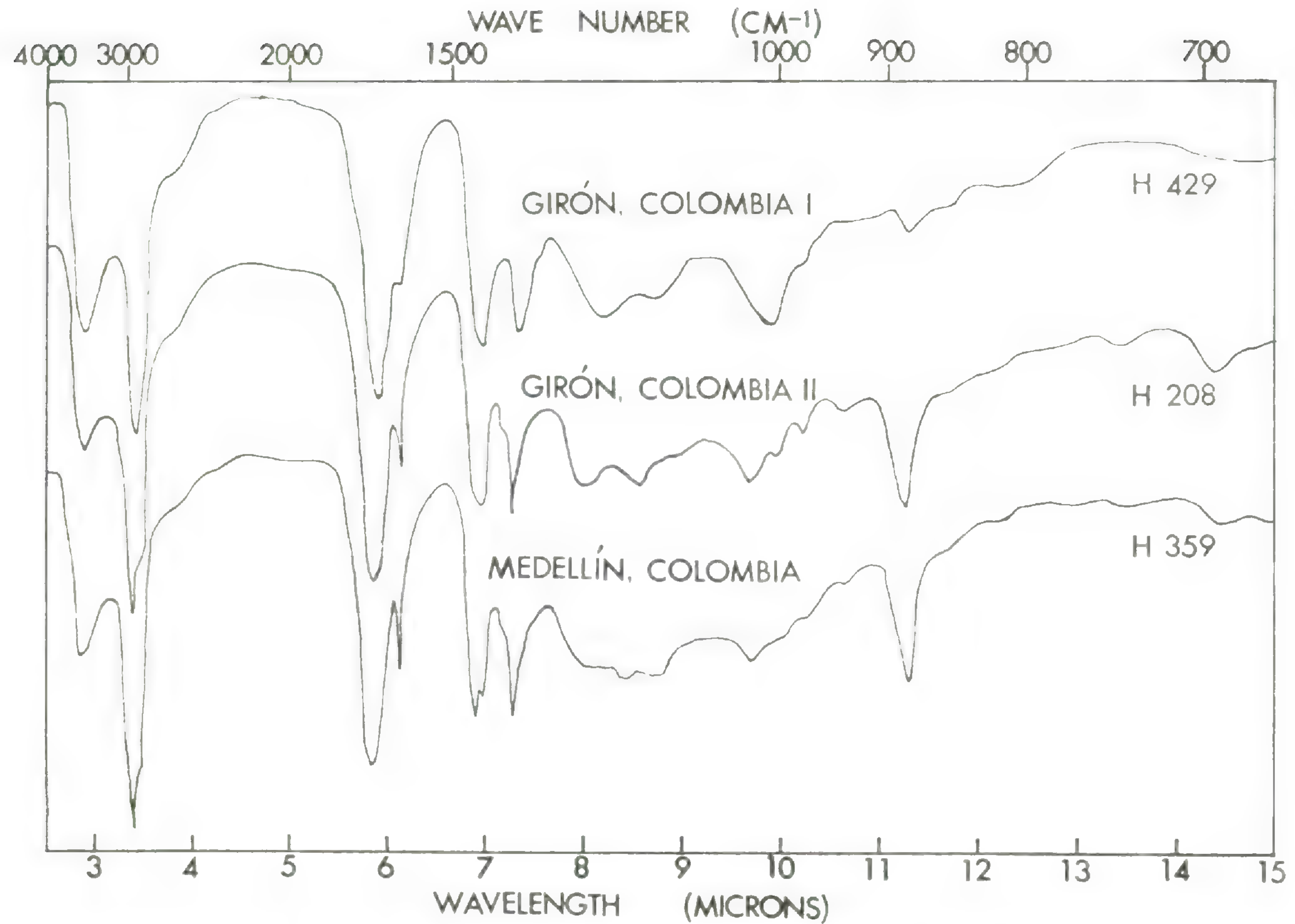
Infrared spectra of Eocene amber from Seattle, Washington, Types I and II and amber of unknown age from Cañon Diablo, Arizona.

[117]



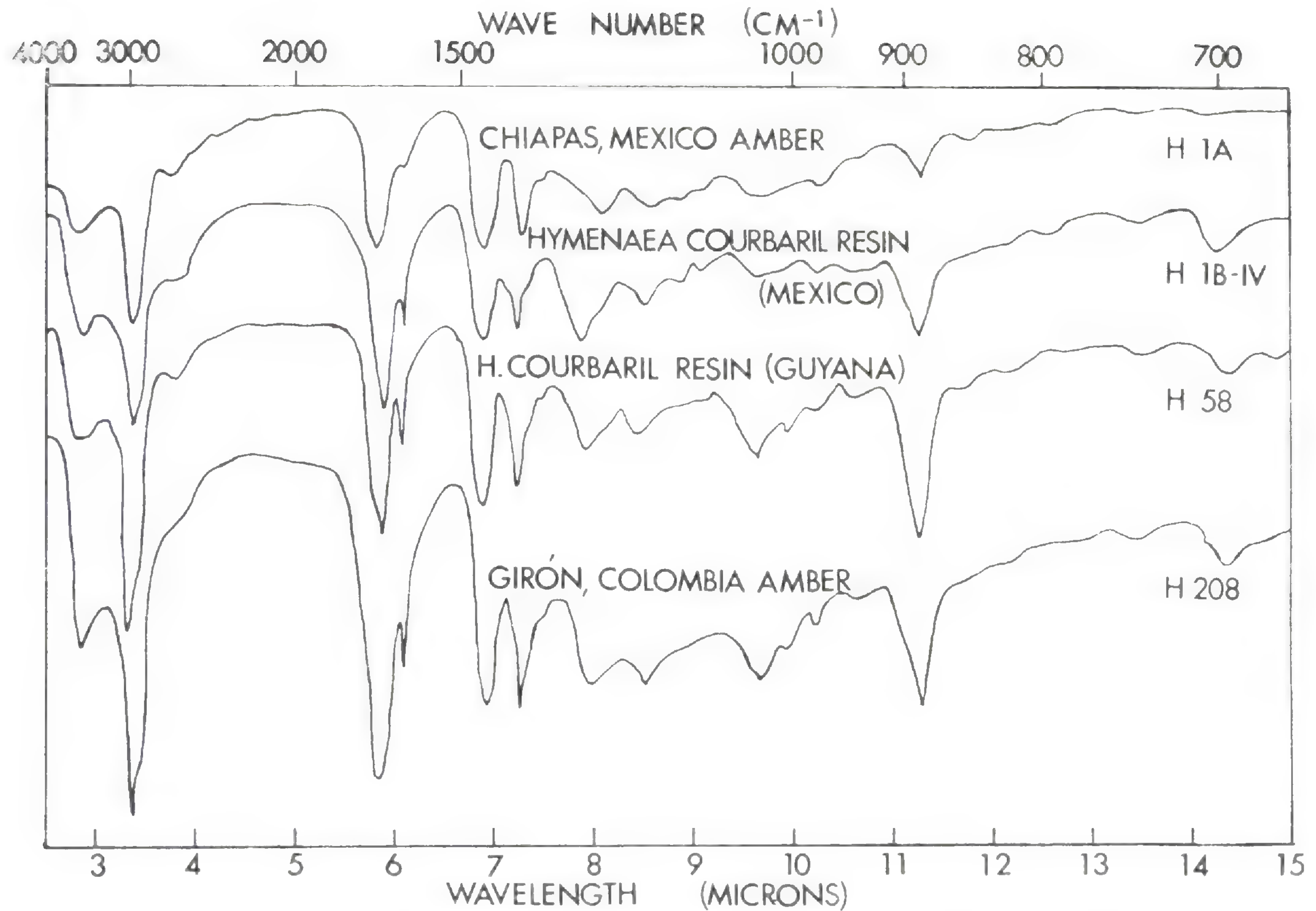
Infrared spectra of Oligocene amber from the Dominican Republic, Types I and II and amber of unknown age from Guayaquil, Ecuador.

[118]



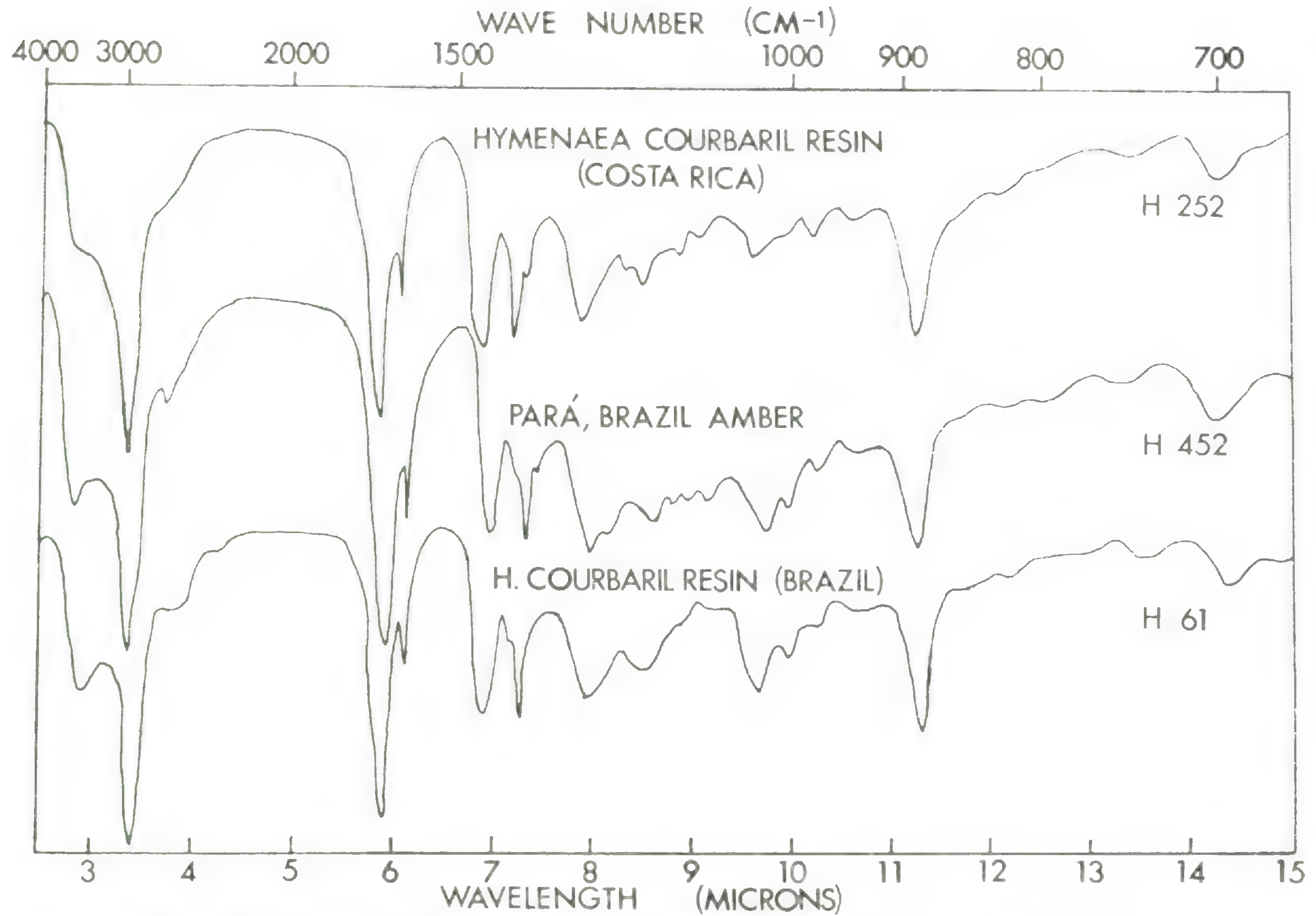
Infrared spectra of amber of unknown age from Girón, Colombia, Types I and II and from Medellín, Colombia.

[119]



Infrared spectra of Oligo-Miocene amber from Chiapas, Mexico, modern resin from *Hymenaea Courbaril* from Mexico and Guyana and, amber of unknown age from Girón, Colombia.

[120]



Infrared spectra of Miocene amber from Pará, Brazil, and modern resin of *Hymenaea Courbaril* from Costa Rica and Brazil.

BOTANICAL MUSEUM LEAFLETS

HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, JANUARY 10, 1969

VOL. 22, No. 4

DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES III

PHYTOCHEMICAL EXAMINATION OF SPRUCE'S ORIGINAL
COLLECTION OF BANISTERIOPSIS CAAPI

BY

RICHARD EVANS SCHULTES¹, BO HOLMSTEDT
AND JAN-ERIK LINDGREN²

RICHARD SPRUCE, the humble Yorkshire schoolmaster-bryologist, became one of the outstanding tropical plant explorers of all time. On July 12, 1849, he arrived at the mouth of the Amazon to start his epoch-making botanical studies and collections that spanned a period of fifteen years (1849-1864) in the Amazon and the Andes.

Spruce (Plate XXX) was far ahead of his day in scientific thought and method. He lived closely with native peoples, learned several languages and kept his mind ever inquisitive and his eye ever perceptive. For a number of plants that have later attracted extensive phytochemical and pharmacological attention — and which are still claiming serious studies — it was Spruce who gave us detailed, accurate, pioneer information.

One of these plants was a jungle liana, source of an extraordinary hallucinogenic drink called *caapi* in Brazil, *ayahuasca* in Ecuador and Peru. It was in 1852, during

¹ Botanical Museum of Harvard University, Cambridge, Mass.

² Department of Toxicology, Swedish Medical Research Council, Karolinska Institutet, Stockholm, Sweden.

the early stages of his five years of field work on the upper Rio Negro in Amazonian Brazil, that Spruce first learned of caapi amongst the Tukanoan tribes of the region. It was employed to induce, for prophetic and divinatory purposes, an intoxication characterized, amongst other strange syndromes, by frighteningly realistic colored visual hallucinations and a feeling of extreme and reckless bravery. Unlike many early reports of newly discovered narcotics, Spruce's contribution included a precise determination of the botanical source of the drug.

Finding caapi cultivated along the Rio Negro, he noted that "there were about a dozen well growing plants . . . twining up to the tree tops . . . and several smaller ones. It was fortunately in flower and young fruit; and I saw, not without surprise, that it belonged to the . . . Malpighiaceae . . ." A collection in full flower (*Spruce 2712*) was taken from the liana, and he drew up a description of the species from living specimens. He allocated the species to the genus *Banisteria*, calling it *Banisteria Caapi* from the vernacular name. This description was published by the botanist Grisebach. As taxonomic understanding of the family grew in the present century, the American specialist, C.V. Morton, ascertained that this species-concept could not with precision be included in *Banisteria*, and, in 1931, he transferred it to the genus *Banisteriopsis*. The liana is, accordingly, now correctly called *Banisteriopsis Caapi* (*Spruce ex Grisebach*) Morton. *

Even a century ago, Spruce's thinking was, at least in part, along chemotaxonomical directions. He mused:

****Banisteriopsis Caapi* (*Spr. ex Griseb.*) Morton** in Journ. Wash. Acad. Sci. 21 (1931) 485.

Banisteria Caapi Spruce ex Grisebach in Martius Fl. Bras. 12, pt. 1 (1858) 43.

BANISTERIOPSIS *Caapi*
(*Spruce ex Griseb.*) Morton



1, flowering branch, about $\frac{1}{2}$ X. 2, flower, about $2\frac{1}{2}$ X. 3, fruit, somewhat larger than $\frac{1}{2}$ X.

“My surprise arose from the fact that there was no narcotic malpighia on record, nor indeed any species of that order with strong medicinal properties of any kind. *Byrsonima* . . . includes many species . . . their bark abounds in tannins . . . Another genus—*Bunchosia* . . . of the Andes . . . is described in books as poisonous, and if it be really so, then it is the only instance, so far as I know, of the existence of any hurtful principle in the entire family . . . excepting . . . caapi.” “Yet,” he prophetically remarked “strong poisons may lurk undiscovered in many others of the order, which is very large . . . ; and the closely allied soapworts (*Sapindaceae*) contain strong narcotic poisons, especially in the genus *Paullinia*.”

In many ways, Spruce was ahead of his times. In those years, there was little liaison between botanical explorers and chemists of the laboratory. Botanists seldom gathered material for phytochemical study, and in Spruce's case the great distance and isolation of his scene of field work and the primitiveness and absence of normal communications one might believe would have made it impracticable or impossible for him to gather material in bulk for pharmaceutical specialists. Notwithstanding these drawbacks, Spruce did so enrich science, but, like so many collectors even in modern times, he was frustrated in his attempt.

“I obtained a good many pieces of stem [from the type plant of *Banisteria Caapi*], dried them carefully, and packed them in a large box, which contained the botanical [herbarium] specimens, and dispatched them down the river for England in March 1853. The man who took that box and four others on freight, in a large new boat he had built on the Uaupés, was seized for debt when about half-way down the Rio Negro, and his boat and all its contents confiscated. My boxes were thrown

PLATE XXX



RICHARD SPRUCE

Drawn by ELMER W. SMITH

aside in a hut, with only the damp earth for floor, and remained there many months, when my friend Senhor Henrique Antonij of Manáos . . . succeeded in redeeming them and getting them sent to the port of Pará. When Mr. Bentham came to open them in England, he found the contents somewhat injured by damp and mould, and the sheets of specimens near the bottom of the boxes quite ruined. The bundle of the caapi would presumably have quite lost its virtue from the same cause, and I do not know that it was ever analyzed chemically; but some portion of it should be in the Kew Museum at this day."

In an address at the III International Pharmacological Congress in São Paulo, Brazil, in 1966, one of the authors (2, 2a) said: "One of the most interesting exercises that I can imagine would be the analysis of a small portion of this original Spruce material—if, indeed, it is still preserved at Kew—with our modern improved chemical techniques. The active principles of caapi (harmine type alkaloids) might not have deteriorated with the mildew, and it is possible that even in this more than a century of storage, the alkaloids would be intact."

In later discussions of this interesting experiment, we resolved to try to follow it up. Accordingly, on December 21, 1967, we wrote to Sir George Taylor, Director of the Royal Botanic Gardens, Kew, and requested a small amount of the stem material of *Banisteriopsis Caapi* to which Spruce had referred, if it still existed. Shortly thereafter, Sir George and Dr. Patrick Brenan, Keeper, located this valuable historical collection and, on April 26, 1968, sent a letter informing us that some of this material would be made available for chemical study. Also enclosed were notes on the material from the entry book for 1854. The label on the specimens states:

"Stems of *Banisteria* sp. used with the roots and leaves

of *Haemadictyon* in the preparation of an intoxicating beverage called 'Caapi'. Rio Uaupes. *R. Spruce 166. HB 2712.*"

The entry in the notebook reads as follows:

"Portions of the stems of a Malpighiaceae twiner, apparently an undescribed *Banisteria* (2712 to Benth.), called by the Indians Caá-pi; and of the roots and leaves of a *Haemadictyon*, called *Caapi-pinima* (i.e. 'painted caapi') the leaves being veined with red. From these ingredients, the *Banisteria* entering much more largely than the *Haemadictyon*, is prepared an intoxicating drink known to all the natives on the Uaupés by the name of *Caapi*.

"In the Dabocurés (or festas) of the Uaupé Indians, the young men who figure in the dances drink of the Caapi 5 or 6 times during the night, the dose being a cuya, the size of a very small teacup, twice filled. In two minutes after drinking it, its effects begin to be apparent. The Indian turns deadly pale, trembles in every limb, and horror is in his aspect; suddenly contrary symptoms succeed—he bursts into a perspiration and seems popeyed with reckless fury—seizes whatever arms are at hand, his murucú, cutlass, or bow and arrows, and rushes to the doorway, where he inflicts deadly wounds on the ground or doorposts, calling out 'Thus would I do to such a one (naming some one against whom he has a grudge) were he within my reach.' In the space of 10 minutes, the effect passes off, and the Indian becomes calm, but appears much exhausted."

The parts of Spruce's material that reached the Department of Toxicology, Karolinska Institutet, Stockholm, in April 1968 consisted of five pieces weighing in all 26.7 g. (Plate XXXI); 11.5 g. were worked up for analysis by gas chromatography-mass spectrometry and other methods as described earlier (3, 4). The yield of



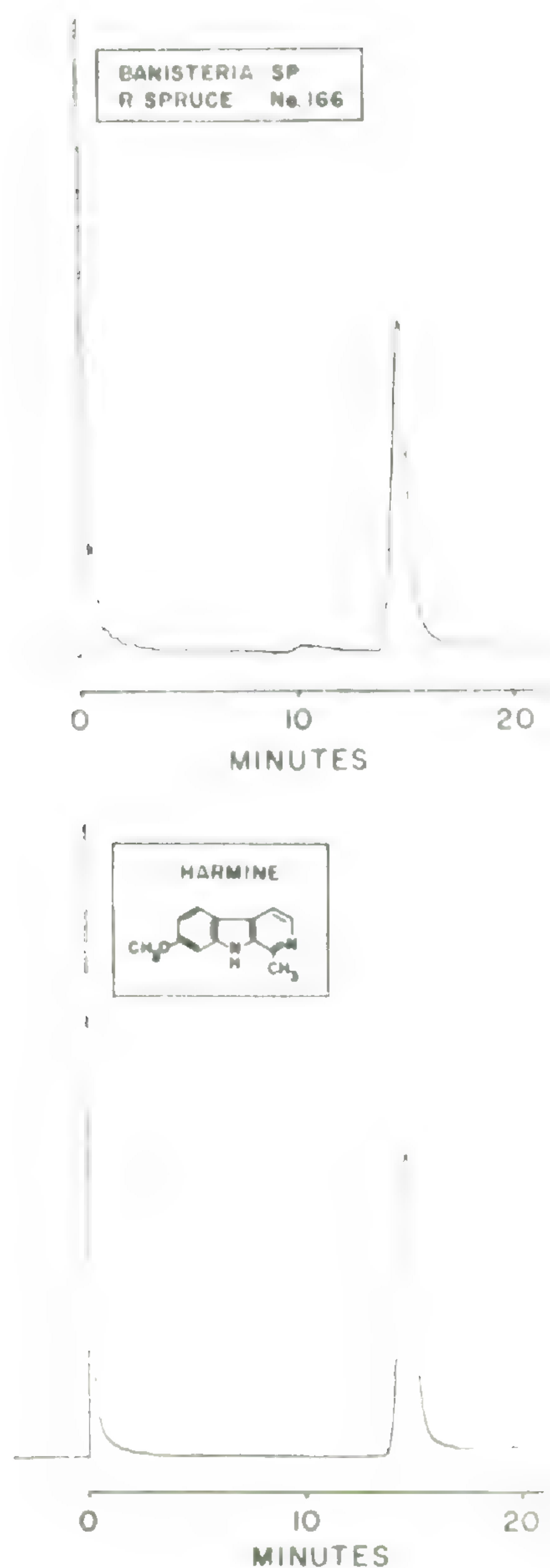
Banisteriopsis Caapi (Spr. ex Griseb) Morton. R. Spruce No. 166.

alkaloids was found to be 0.4 per cent. A newly collected botanically verified specimen of *Banisteriopsis Caapi* analyzed at the same time was found to contain 0.5 per cent alkaloids (5). The latter material contained as described by many authors the main alkaloids harmine, harmaline and tetrahydroharmine (6). In addition, it contained two minor components that will be described separately (5). By contrast, the alkaloid content of the Spruce material *consisted exclusively of harmine*. This was proven beyond any doubt by gas chromatography and the combination of gas chromatography-mass spectrometry. As evident from both the gas chromatograms (Plate XXXII) and the mass spectra (Plate XXXIII), there is complete identity between synthetic harmine and the alkaloid in Spruce's material. It is open to question whether the stems sent home by Spruce in 1853 from the beginning contained only harmine or perhaps more likely that harmaline and tetrahydroharmine have with time been transformed into the chemically more stable aromatic β -carboline, harmine.

Under any circumstances, it is remarkable that Spruce's query about the chemical analysis of the material that fared so badly on its way from the Amazonian rain forest to the Royal Botanic Gardens at Kew has been answered by modern analytical microtechniques 115 years later.

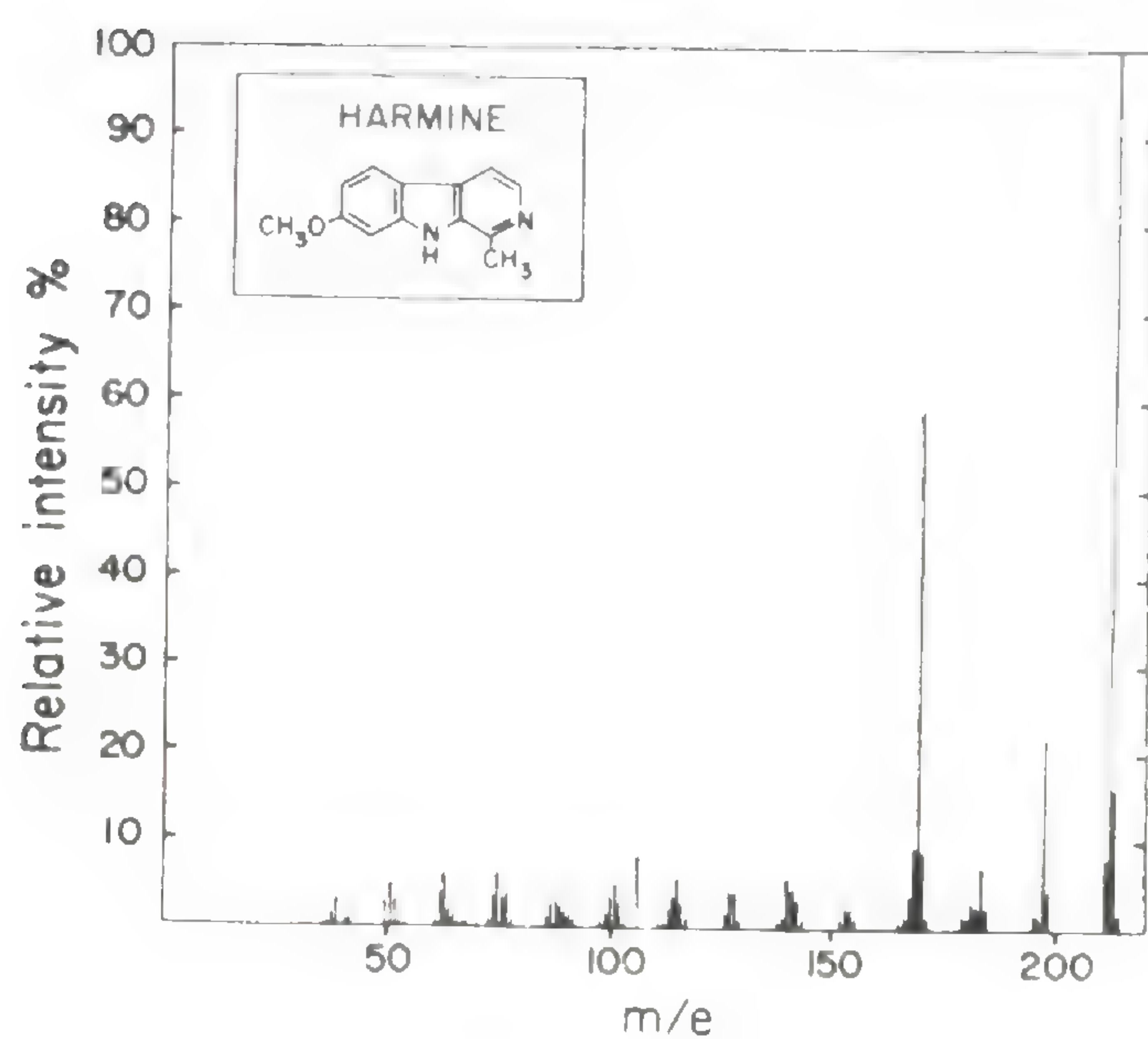
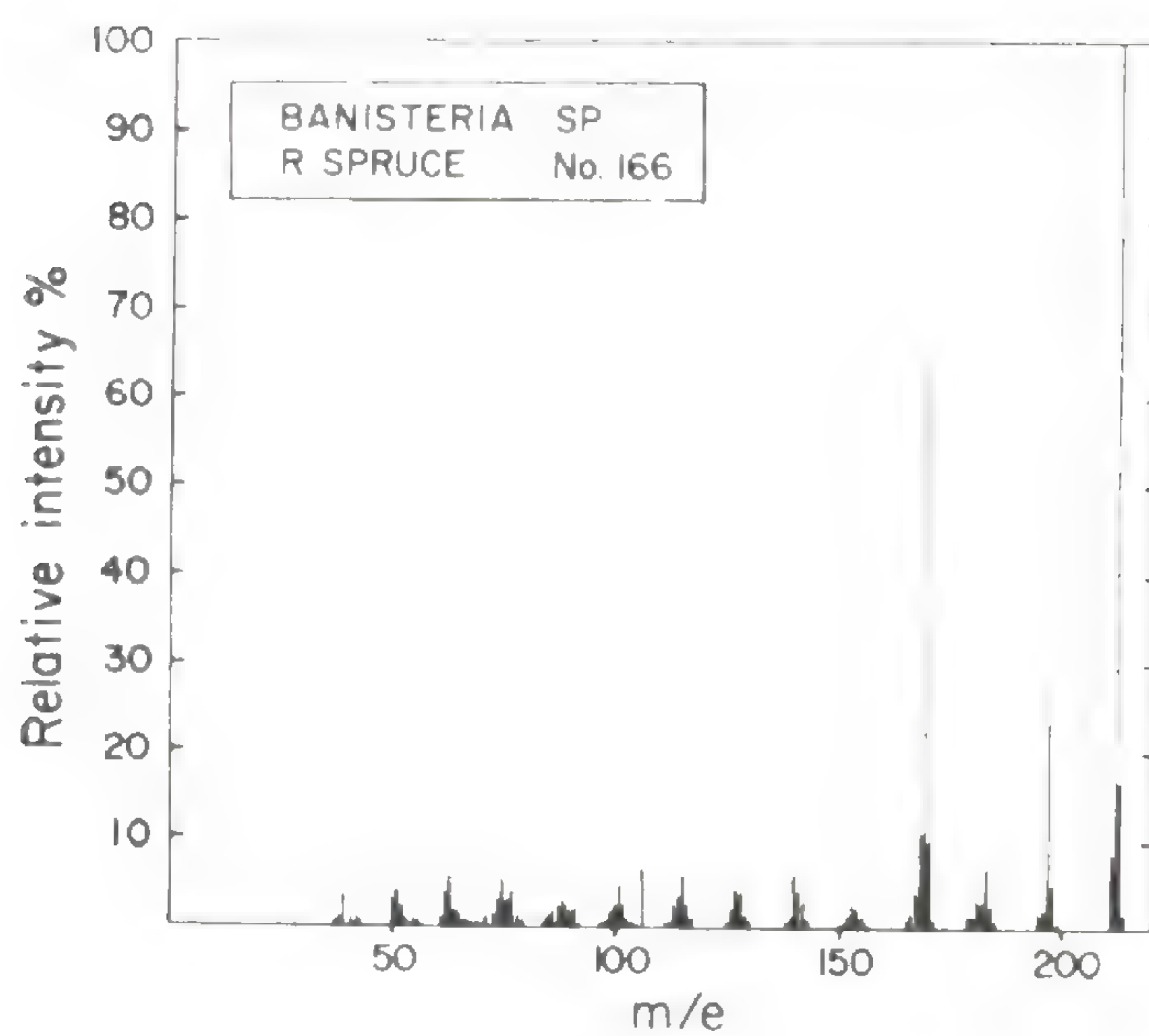
This investigation was supported by grant MH 12007-03 (Holmstedt) and by grant LM-GM 00071-01 (Schultes) from the National Institute of Mental Health, U.S. Public Health Service. We are indebted to Sir George Taylor, Director of the Royal Botanic Gardens, Kew, Surrey, England, for supplying us with the material from Spruce's original collection.

PLATE XXXII



Gas chromatogram of alkaloid fraction from Spruce's material and reference substance. *Conditions:* Column 2 m ; i.d. 3.2 mm ; 5% OV-17 on 100-120 mesh Gas Chrom P ; temp. 230°.

PLATE XXXIII



Mass spectra of peaks shown in Plate XXXII. Conditions as described in Plate XXXII.

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DE PLANTIS TOXICARIIS E MUNDO
NOVO TROPICALE COMMENTATIONES IV

BY
RICHARD EVANS SCHULTES

IN CONTINUATION of a series of articles on toxic plants of the New World tropics, this contribution will call attention to a number of species with miscellaneous interesting ethnobotanical notes as to their use but which, for the most part, have not been subjected to phytochemical examination.

Most of the data reported in the following pages were gathered during field work which I have carried out in the American tropics or which my students have reported as a result of their ethnobotanical studies in sundry parts of Latin America.

It will be clear to phytochemists that the analysis of some of the species enumerated may be of special interest, since a number of the plants belong to genera or even families from which biodynamic constituents have not hitherto been isolated.

The current phases of this research on toxic plants of the New World tropics, including the preparation and publication of most of the plates in this contribution, are supported by a grant from the National Institutes of Health (No. LM-GB 00071-01). The line drawings have been prepared by the late Mr. John Stanwell-Fletcher and by Mr. Gordon W. Dillon, Mr. Joshua B. Clark and Miss Irene Brady.

The enumeration of families follows the Engler-Prantl system.

GARRYACEAE

Garrya laurifolia (*Hartw.*) *Bentham* var. **macrophylla** (*Hartw.*) *Wangerin* in *Pflanzenr.* 4, Fam. 56a (1910) 16.

MEXICO: Estado de Oaxaca, Cerro Zempoaltepetl, eastern slope. Alt. 2600 m. "Very large shrub along forest trails." May 26, 1939. *R.E. Schultes* 547.

The Mije Indians living near the base of Cerro Zempoaltepetl employ the leaves and stems in the form of a decoction as a febrifuge, but when taken in excess this medicine reputedly causes a burning sensation in the digestive tract and a strong trembling of the hands.

Garrya laurifolia, known in Mexico as *cuauhchichic*, is employed therapeutically in tincture or extract form in the treatment of chronic diarrhoea. Several analyses have been made, and it has been established that the bark infusion kills rabbits by paralysis of the respiratory centres (Martínez, M. : "Plantas medicinales de Mexico" ed. 4 (1959) 93-96). Amongst other constituents, it is said to contain a bitter alkaloid principle, garryine, a resin, tannic acid and a compound possibly of glycosidal nature. Several alkaloids have been isolated from the genus *Garrya*, including *G. laurifolia* var. *macrophylla* (Hérissey, H. and C. Lebas in *Journ. Pharm. Chim.* 2 (1910) 490; Oneto, J.F. in *Journ. Am. Pharm. Assoc.* 35 (1946) 204).

ANNONACEAE

Unonopsis veneficiorum (*Mart.*) *R.E. Fries* in *Acta Hort. Berg.* 12 (1937) 238.

COLOMBIA: Comisaría del Putumayo, Río Guamües, Santa Rosa. "Primary forest. Small tree more or less 20 ft. Bark of root is used in preparation of curare." November 26, 1966. *H.V. Pinkley* 558.

PLATE XXXIV

UNONOPSIS venificiorum (Mart.) R.E.Fr.



1, habit, approximately $\frac{1}{4} \times$. 2, flower, approximately $2\frac{2}{3} \times$. 3, immature fruits, approximately $2\frac{2}{3} \times$. 4 and 5, seed, approximately natural size. 6, fruits, approximately $\frac{1}{2} \times$.

Mr. Homer V. Pinkley, one of my graduate students who spent more than a year in ethnobotanical studies amongst the Kofán Indians of Ecuador and Colombia, reports that the root of this small tree, known in Kofán as *i-te-si-fan-di*, is the source of a curare preparation of the tribe.

This species was first reported as an arrow poison ingredient by Martius (Spix, J.B. and K.F.D. Martius "Reise in Brasilien" (1831) 1237), who stated that the Juri, Miraña and other Indians of the Rio Japurá (Río Caquetá) and Rio Negro of Colombia and Brazil so employed it. *Unonopsis veneficiorum* has been reported as containing bisbenzylisoquinoline alkaloids (Hegnauer, R. "Chemotaxonomie der Pflanzen" 3 (1964) 118).

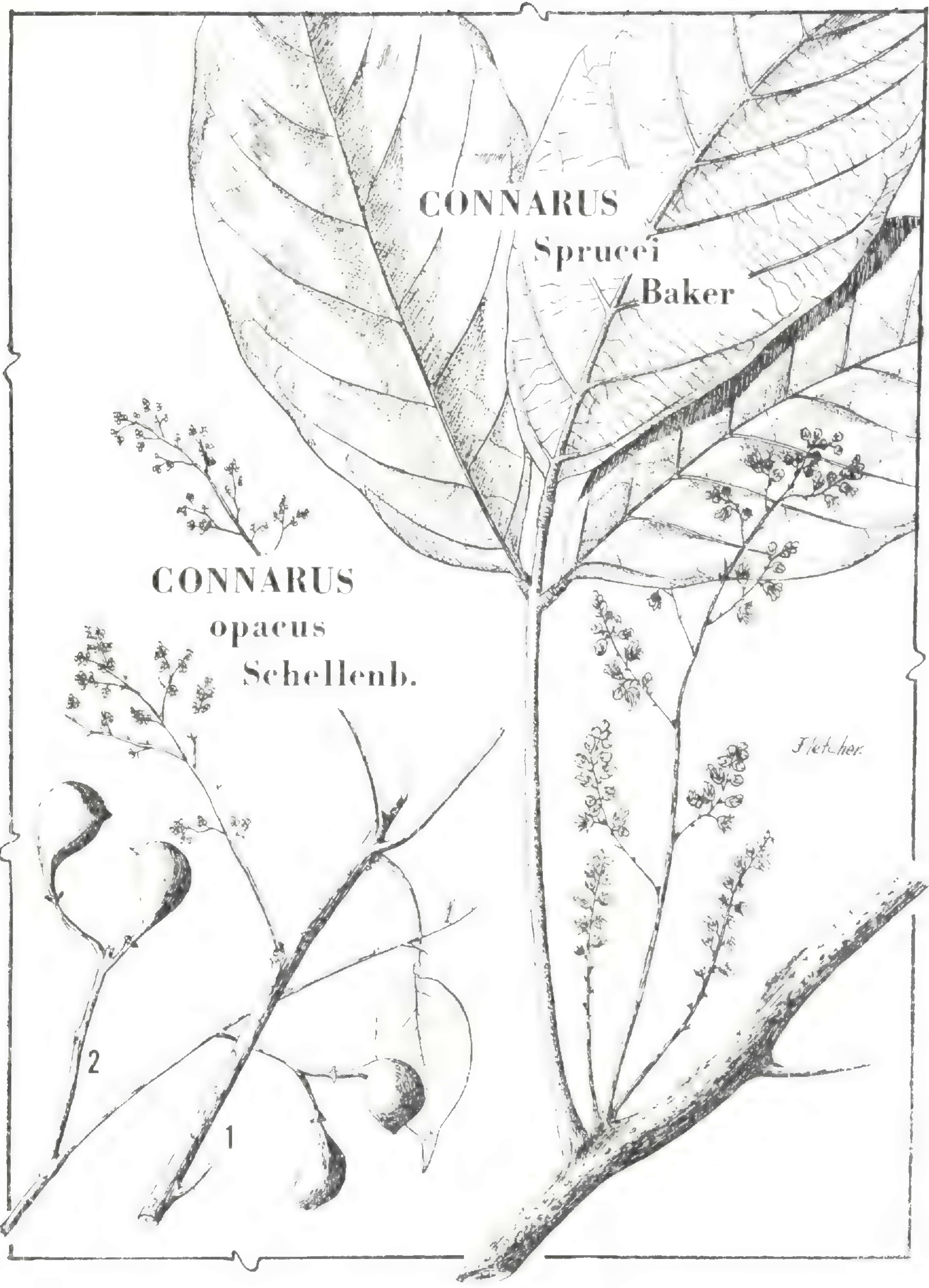
Mr. James W. Walker of the Gray Herbarium of Harvard University has identified the collection *Pinkley 558*.

CONNARACEAE

The chemistry of the Connaraceae is very poorly known and most certainly represents one of the areas in the angiosperms where phytochemists should concentrate attention. Dye materials and balsamic resins are rather common in the family, and, although very poisonous substances have been reported from the fruit, seeds and bark of some species, their chemical nature is not yet clarified (Hegnauer, loc. cit.) 3 (1964) 545–546. As a family very closely allied to the Leguminosae, the Connaraceae should be expected to possess a good number of species employed as poisons in primitive societies.

My identification of the connaraceous species mentioned in this paper has been verified by Dr. Gilian T. Prance of the New York Botanical Garden.

Connarus opacus *Schellenberg* in Engler Pflanzenr. 4, Fam. 127 (1938) 244.



Habit, approximately $\frac{1}{2} \times$.

COLOMBIA: Comisaría del Vaupés, Río Kuduyarí, headwaters. "Li-ana. Fruits dull red. Bark and leaves used by Kubeo for fish poison." August 16, 1960. *R.E. Schultes 22719*.

This extensive vine, which is relatively abundant in the headwaters of the Río Kuduyarí as an element of the riverside vegetation, provides one of the usual fish poisons employed in still water by the Kubeo Indians. The root and stem bark and leaves are mixed together, crushed, placed in a bag and drawn slowly through the water.

A spot test for alkaloids, made on the dried leaves of this collection, was negative. Alkaloids have apparently never been reported from any species of the Connaraceae (Willaman, J.J. and B.G. Schubert: "Alkaloid-bearing plants and their contained alkaloids" Techn. Bull. No. 1234, U.S.D.A. (1961).

The collection *Schultes 22719* is apparently the first record of this species from Colombia. The type was collected in British Guiana by Schomburgk.

Connarus Schultesii *Standley* ex Schultes in Bot. Mus. Leaflet, Harvard Univ. 9 (1941) 173, t. 4.

MEXICO: Estado de Oaxaca, San Juan Lalana, Distrito de Choapam. Alt. 700 m. "A tangled vine growing on large forest trees, mountain southeast of Lalana. Stems exude red sap upon breaking." May 9, 1939. *R.E. Schultes et B.P. Reko 833*.

Known only from the type collection, this species has been employed by the Chinantec Indians as a taenifuge. The extremely bitter red sap that exudes from the stems acts in the expulsion of certain intestinal parasites, but it is reputedly toxic in large doses. Since the species is reported by the natives to be local, its use in folk-medicine appears to be restricted. It is perhaps of interest that an African species is similarly employed (Heckel, E., and F. Schlagenhaußen in Ann. Fac. Sci. Marseilles 6, fasc. 2 (1897) 1-26). The only other species recorded from

CONNARUS

Schultesii

Standley

1

2

GORDON
W.
DILLON

1, fruiting branch, approximately $\frac{1}{2} \times$. 2, fruit, enlarged approximately $1\frac{1}{2} \times$.

Mexico—*Connarus lentiginosus* Brandg. of Chiapas—is not known to be utilized medicinally, but ethnobotanical studies have not been pursued in the region.

The red sap of *Connarus Schultesii* may contain coloring constituents, but the Chinantecs and neighboring Zapotecs apparently do not make use of them as a dye.

Connarus Sprucei *Baker* in Martius Fl. Bras. 14, pt. 2 (1871) 187.

COLOMBIA: Comisaría del Vaupés, Río Kuduyarí, near mouth. “Vine. Flowers white. Bark employed as fish poison.” August 12, 1960. *R. E. Schultes* 22576.

The bark of the root and stem of this riverside liana is employed by the Kubeo Indians as a fish poison.

Spot tests for alkaloids, made on the bark of the species, proved to be negative.

Rourea glabra *Humboldt, Bonpland et Kunth*. Nov. Gen. et Sp. 7 (1825) 41.

COLOMBIA: Comisaría del Amazonas, Río Karaparaná, between the mouth and El Encanto. Alt. about 150 m. “Small tree. Fruit red with blackish blue husk.” May 22–28, 1942. *R. E. Schultes* 3831.

The Witoto Indians use the root and stem bark of *Rourea glabra* as a fish poison. This small tree or vine is rather common in pockets along the flood-banks of the Río Karaparaná. Although it is a widespread species, occurring in Central America, the West Indies and tropical South America, no uses seem to have been reported for it beyond the employment of a decoction as a gargle in treating catarrhal conditions (Schellenberg, loc. cit. 214). Two vernacular names for the plant in Brazil—*mata cachorro* (“dog killer”) and *mata negro* (“negro killer”)—do, however, suggest poisonous properties. The fruit and root bark of *Rourea crecta* (Blanco) Merr., an Asiatic species, are reputedly poisonous to dogs and other car-



ROUREA glabra H.B.K.

Habit, approximately $\frac{1}{2}$ $\times$.

nivorous animals (Brill, H.C. and A.H. Well in Philippine Journ. Sci. 12A (1917) 171). A steroidal sapogenine has been found in the leaves and twigs of *Rourea ligulata* Bak. of Brazil (Altman, R.F.A. in Nature 173 (1954) 1098).

EUPHORBIACEAE

Phyllanthus lathyroides *Humboldt, Bonpland et Kunth* Nov. Gen. et Sp. 2 (1817) 110.

MEXICO: Estado de Oaxaca, Distrito de Teotitlán, Huautla de Jiménez. August 3, 1938. *R.E. Schultes et B.P. Reko* 417.

This common roadside weed, called *shka-nin-du* ("eruption plant") in the Mazatec Indian language, has medicinal properties, according to the natives. A decoction of the leaves is used as a wash for eye infections, such as conjunctivitis. A poultice of moistened leaves is applied to boils, hence the Indian name of the plant. A strongly emetic tea is, likewise, prepared from the leaves.

FLACOURTIACEAE

Lunania parviflora *Spruce* ex Benth in Journ. Linn. Soc. 5, Suppl. 2 (1861) 90.

COLOMBIA: Comisaría del Amazonas, Trapecio Amazónico, Río Loretoyacu. September 1946. *R.E. Schultes et G.A. Black* 8316.

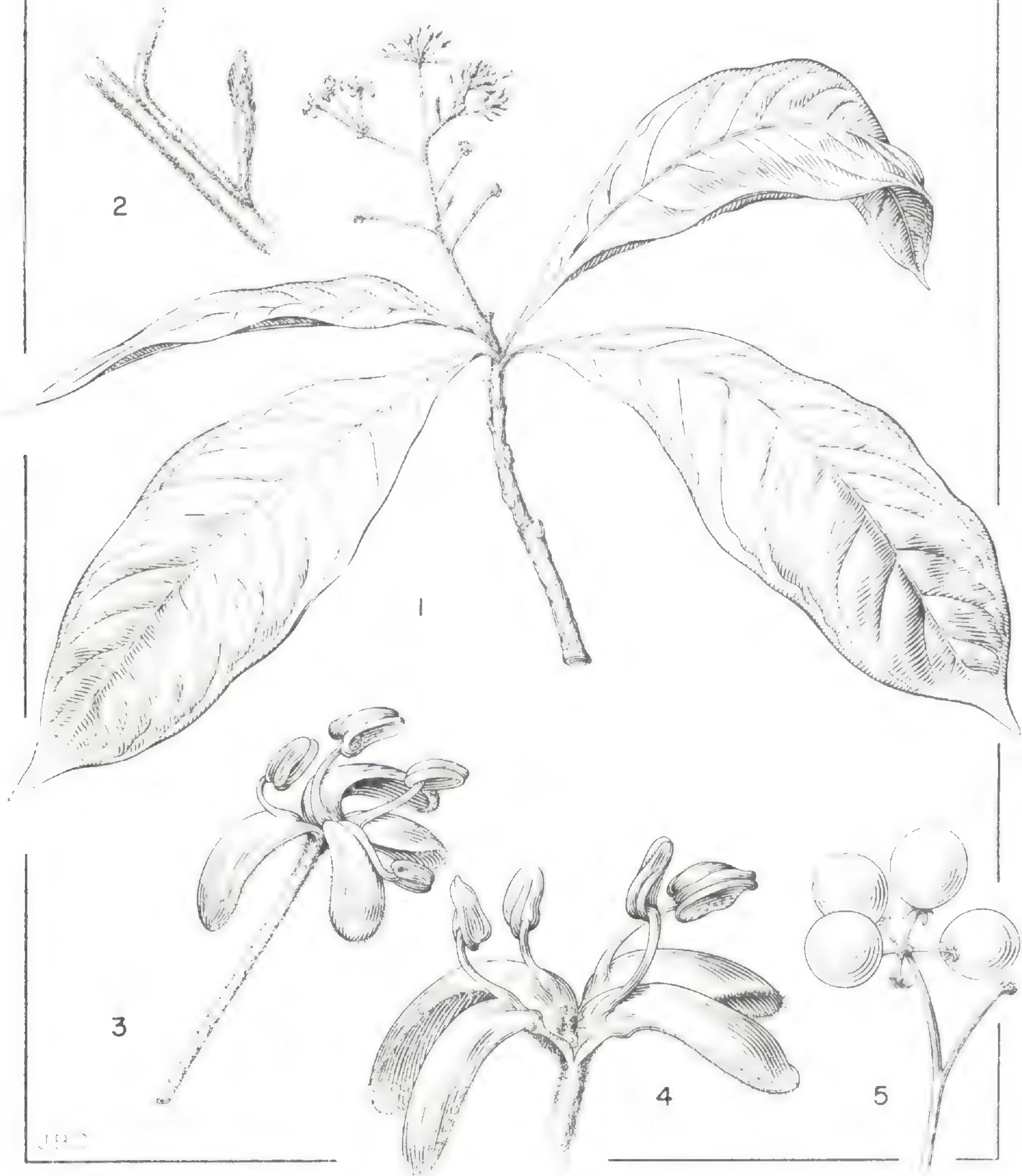
The Tikuna Indians report that the root of *Lunania parviflora* is toxic and was formerly powdered and added to cooked food for the purpose of killing enemies or unwanted visitors from foreign tribes.

THYMELAEACEAE

Schoenobiblus peruvianus *Standley* in Field Mus. Publ. Bot. 11 (1936) 169.

COLOMBIA: Comisaría del Putumayo, Río Sucumbíos (San Miguel), Conejo y alrededores, frente a la Quebrada Conejo. "Large shrub. Root furnishes one of the poisons for curare." April 2-5, 1942. *R.E.*

SCHOENOBIBLUS peruvianus Standl.



1, habit, approximately $\frac{3}{8} \times$. 2, leaf and bractlet, approximately $2 \times$. 3, flower, approximately $4 \times$. 4, flower, approximately $6 \times$. 5, fruit, approximately $\frac{2}{3} \times$.

Schultes 3521.—"Poison. Fruits used in making curare. Shrub." April 2-5, 1942. *Schultes 3655*.—Santa Rosa y alrededores. "Roots and fruits used in Kofán curare preparation." April 7-8, 1942. *Schultes 3613*.—Río Guamües, Santa Rosa. Alt. 990 ft. "Low and swampy area. Plant $4\frac{1}{2}$ ft. tall. Fruit bright orange. Root and fruit used in arrow poison; also sometimes used as a fish poison." September 6, 1966. *H.V. Pinkley 435*.

In 1949, Schultes (in Bot. Mus. Leaflet Harvard Univ. 13 (1949) 285-289) reported the use of *Schoenobiblus peruvianus* as "a very important ingredient in the arrow-poisons of the Kofán Indians of the Putumayo" in Colombia along the Ecuadorian border. The roots and the fruits are employed.

Mr. Pinkley, as a result of his year-long ethnobotanical studies amongst the Kofán Indians, has been able to conclude a detailed study of the employment of this interesting toxic plant in the preparation of arrow poisons, a report of which will be published elsewhere. His record that the plant is sometimes utilized as a fish poison extends our knowledge of its toxic activity and may be of interest chemically, inasmuch as the identity of the active principle is, as yet, unknown.

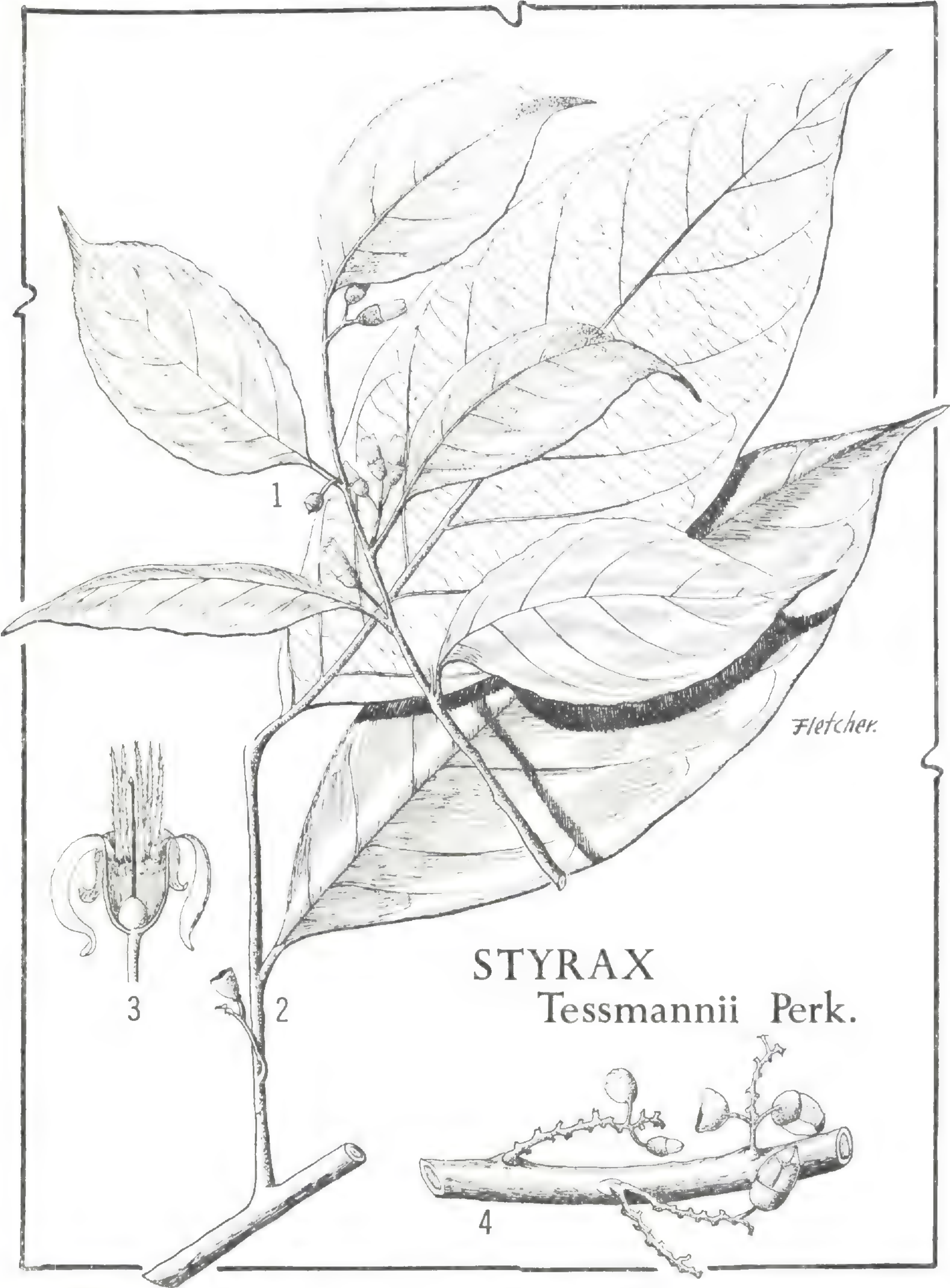
The identification of the specimens cited above has been checked by Dr. Loren I. Nevling of the Arnold Arboretum.

STYRACACEAE

***Styrax Tessmannii* Perkins** in Notizbl. 10 (1928) 459.

COLOMBIA: Comisaría del Amazonas, Trapecio Amazónico, Río Loretoyacu. Tikuna name: *mē-re-ta-kee*. March 1946. *R.E. Schultes 7144*.

According to Tikuna Indians living along the Río Loretoyacu, the aromatic resin from the stems of *Styrax Tessmannii* is poisonous when ingested. This has apparently not hitherto been reported, but, in view of persistent information to this effect, it bears phytochemical investigation.



1, habit of flowering branch, approximately $\frac{1}{2} \times$. 2, habit of fruiting branch, approximately $\frac{1}{2} \times$. 3, flower, approximately $2\frac{1}{2} \times$. 4, fruit, approximately $\frac{1}{2} \times$.

GENTIANACEAE

Chelonanthus alatus (Aubl.) Pulle Enum. Vasc. Pl. Surinam (1906) 376.

MEXICO: Estado de Oaxaca, Distrito de Cuicatlán, between San Juan Zautla and Teutila. June 30, 1939. *R.E. Schultes* 731. — Distrito de Choapam, San Juan Lalana. May 3, 1939. *R.E. Schultes et B.P. Reko* 785.

COLOMBIA: Comisaría del Amazonas, Río Karaparaná, between the mouth and El Encanto. May 22–28, 1942. *R.E. Schultes* 3805. — Comisaría del Vaupés, Río Vaupes, Mitú and vicinity. September 27–October 20, 1966. *R.E. Schultes, R.F. Raffauf et D. Soejarto* 24246a — *Schultes, Raffauf et Soejarto* 24346.

PERU: Departamento de Loreto, Río Napo, Negro Urco. August 16, 1966. *R.T. Martin et C.A. Lau-Cam* 1286. — *Martin et Lau-Cam* 1290.

The Chinantecs in the Districts of Choapam, Ixtlán and Cuicatlán, Oaxaca, state that the root of *Chelonanthus alatus* is bitter and is used in decoction as a febrifuge, for cramps and indigestion, and to treat sores in the mouth. It has uses similar to those of *Lisianthus nigrescens* reported below. Applications based on its bitter principles are recorded from French Guiana (Heckel, E. “Les plantes médicinales et toxiques de la Guyane Française” (1897) 57). Aublet, who described the concept, reported its employment in folk medicine in French Guiana as early as 1775 (Aublet, J.B.C.F. “Histoire des plantes de la Guiane Française” 1 (1775) 205), stating: “The whole plant is bitter. It is used to treat obstructions, and I have employed it for this purpose with success”.

The Witoto Indians of Amazonian Colombia, who refer to the plant as *ho-ko-so-gö-nö*, dry and pulverize the leaves and flowers for powdering clothing and bedding to ward off insects.

Field spot tests on fresh material in Colombia have indicated that no alkaloids are present in the plant.



Habit, approximately $\frac{1}{2}$. . . Flower dissected, approximately natural size.
Anther, approximately $6\frac{1}{4}$ $\times$.

Several specimens collected in eastern Peru (*Martin et Lau-Cam* 1286 and 1290) reported a vernacular name *amaraguña* which presumably refers to the bitter principles in this plant. Another name employed for this species in eastern Peru is *uña de tigre*. A Peruvian collection (*Mería* 4153), referable to *Chelonanthus chelonoides* (L.) Gilg, records that the plant is "used as a remedy for worm-infested wounds in cattle".

Lisianthus nigrescens *Chamisso et Schlechtendahl*
in *Linnaea* 9 (1831) 388.

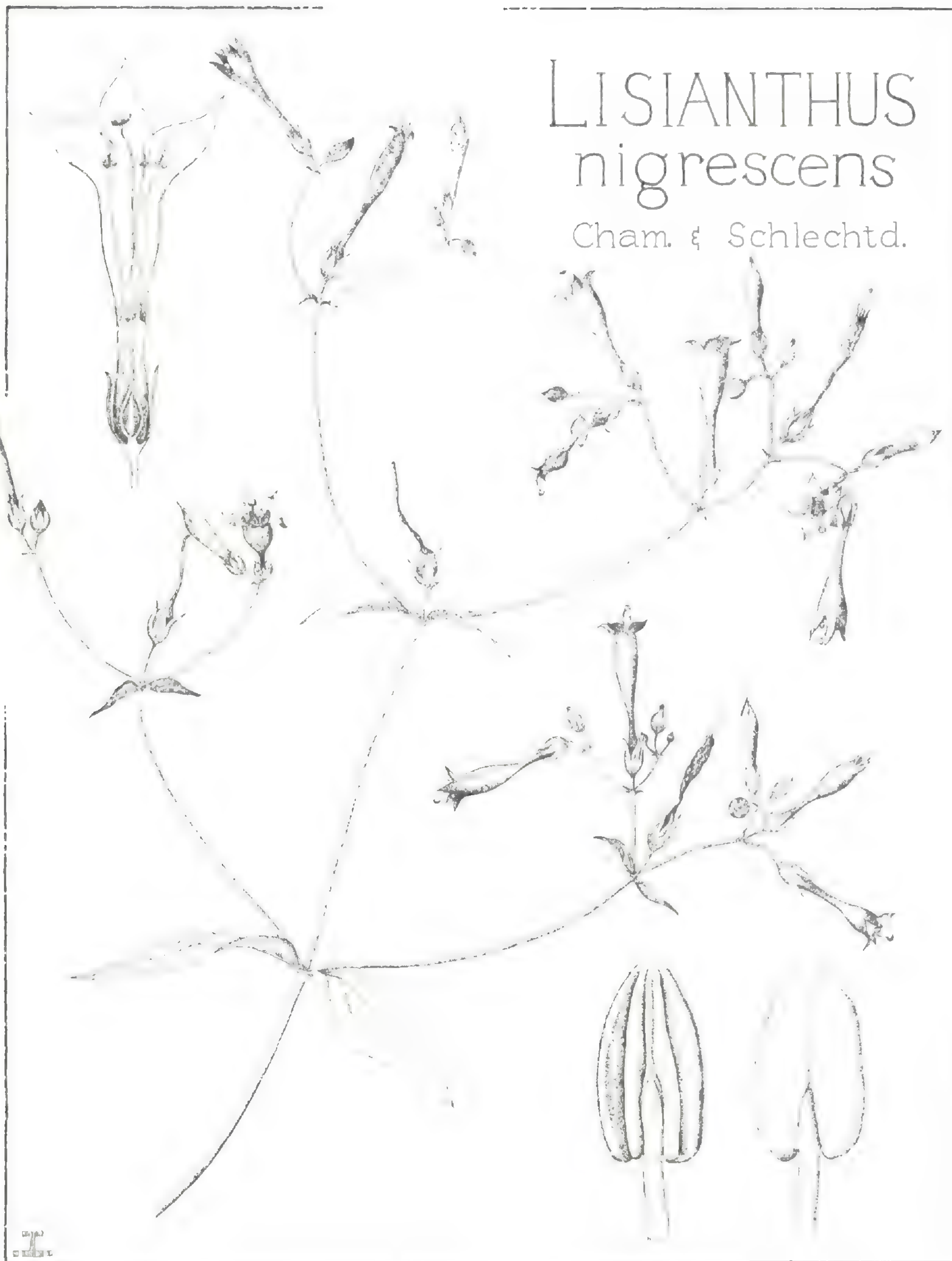
MEXICO: Estado de Oaxaca, Distrito de Choapam, Santiago Zacatepec. *R.E. Schultes* 514.—Between Choapam and San Juan Comaltepec. June 3, 1939. *Schultes* 573.—Tonanguilla. June 4, 1939. *Schultes* 591.—Estado de Oaxaca, Distrito de Choapam, San Juan Lalana. May 6, 1939. *R.E. Schultes et B.P. Reko* 772.—Between Latani and Choapam. May 13, 1939. *Schultes et Reko* 889.

This striking, almost black-flowered herb occurs widely in northeastern Oaxaca, where it enjoys a variety of folk uses. Amongst the western Chinantecs, a decoction of the roots is employed to relieve indigestion and heartburn and as a febrifugal tonic. The neighbouring Mazatecs apparently utilize the plant medicinally only "contra el aire". The Mije Indians of Zacatepec apply a poultice of the leaves in the treatment of fungal infections of the skin of the feet, ankles and hands and value a decoction of the root as a bitter and febrifuge. Amongst the Zapotecs of Villa Alta and vicinity, the black, sticky flowers of this species are prepared in a wash employed to remove *pinolillos* (ticks) from the body, a use that is the basis of the Zapotec names *be-zia* and *o-zia* ("remedy against ticks").

Lisianthus nigrescens has apparently not hitherto been reported as a useful plant, although other species, known to possess the bitter properties characteristic of the Gentianaceae, find medicinal employment in various

LISIANTHUS
nigrescens

Cham. & Schlechtd.



Habit, approximately $\frac{1}{2} \times$. Flower dissected, approximately natural size.
Anthers, approximately $10 \times$.

parts of tropical America. The Brazilian *Lisianthus pendulus* Mart., for example, is valued as a bitter tonic and febrifuge; several other species are similarly used in French Guiana (Heckel, loc. cit., 57). The insectifugal properties of *Lisianthus nigrescens* seem not to have been recorded, and, in view of a similar use of a species of the closely allied genus *Chelonanthus* (see above), they would appear to be worth investigating.

In northeastern Oaxaca, this plant is known amongst the Chinantecs as *lee-the*. The Mazatecs of Huautla refer to it as *shka-tee-tso*. The Mije call it *yerk*.

GESNERIACEAE

Nautilocalyx sp.

COLOMBIA: Comisaría del Vaupés, Río Vaupés, savannah at base of Cerro de Mitú. September 27–October 20, 1966. *R.E. Schultes, R.F. Raffauf et D. Soejarto 24211*. “Flowers white. Terrestrial.”

A spot test for alkaloids, given on fresh material in the field, was positive. This result is noteworthy in view of the fact that evidence of alkaloids in this family is almost wholly negative. An unknown alkaloid has been reported from the European *Ramondia pyreaica* Rich. Alkaloid spot tests made on several species of *Besleria* (*B. ignea* Fritsch: *Schultes, Raffauf et Soejarto 24053*) and *Alloplectus* (*A. semicordatus* P. et E.: *Schultes, Raffauf et Soejarto 24225*) from the Colombian Amazon were negative.

The collection *Schultes, Raffauf et Soejarto 24211* is sterile. It has been identified to genus by Dr. H. Emery Moore of the Bailey Hortorium.

RUBIACEAE

Duroia *L. fil.*

Although this genus has apparently not been recorded as toxic, the number of reports from natives affirming

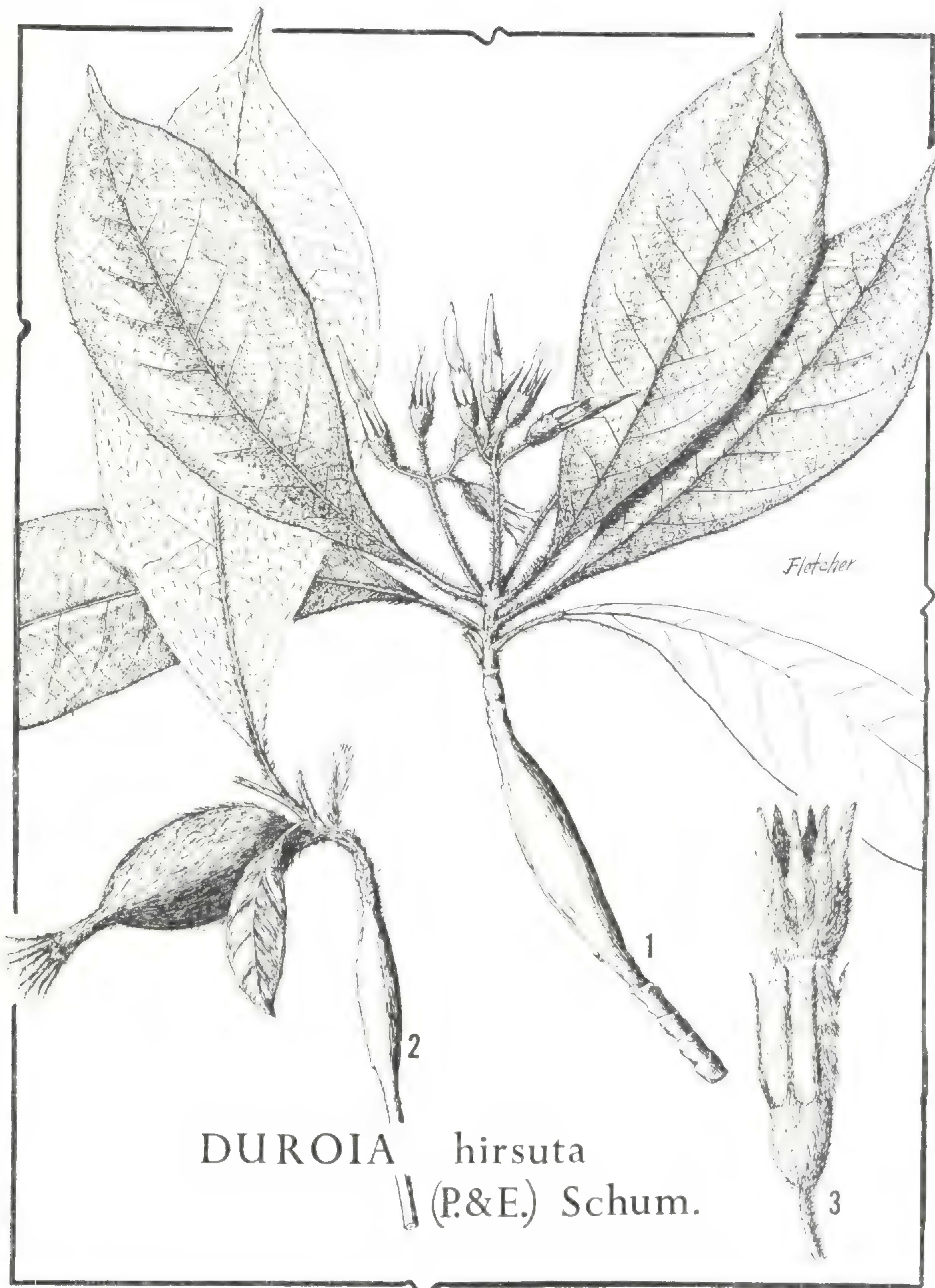
the poisonous properties of the seeds of several species, all reports from widely separated localities, calls attention once again to the need for phytochemical studies guided by ethnobotanical observations.

***Duroia hirsuta* (P. et E.) K. Schumann** in Martius Fl. Bras. 6, pt. 6 (1889) 367.

COLOMBIA: Departamento del Cauca, Puerto Limón, bosques en el lado caucano del Río Caquetá. Alt. 300 m. "Small tree. Bark, tied on arm, forms blisters, *Solimán*." February 28–29, 1942. *R.E. Schultes* 3320.—Comisaría del Putumayo, Río Sucumbíos, Conejo and vicinity. "Kofán = *sha-ka-ker-ná-sě*" April 2–5, 1942.—Comisaría del Amazonas, Río Caucaya, between Puerto Jaramillo and Río Putumayo. May 16, 1942. *R.E. Schultes* 3712.—Comisaría del Vaupés, Río Apaporis, near confluence of Ajaju and Macaya. *Solimán*. "January 1944. *G. Gutiérrez et R.E. Schultes* 612.—Intendencia del Meta, Sabanas de San Juan de Arama, margen izquierda del Río Gúejar, alrededores de aterrizaje Los Micos." Alt. about 500 m. "Arbolito de 3 m. de alto. Común en bosque." December 5–20, 1950. *J.M. Idrobo et R.E. Schultes* 594.

The type collection of *Duroia hirsuta* was made in Villavicencio, Colombia. *Idrobo et Schultes* 594, consequently, from near the town of Villavicencio, may be considered topotypical.

Amongst many Indians of the Colombian Amazon and Putumayo—especially the Kofán, Siona, Witoto and Tikuna—the caustic bark of this small tree is employed to make bluish black markings on arms and legs. Strips of the freshly removed, pliable bark are tied onto the arm or leg with the inner surface of the bark touching the skin. After several hours or half a day, it is removed. Blisters and a localized red swelling result in another two to three hours. When this condition disappears, a dark band persists and lasts for several weeks, even occasionally for several months. There have apparently been no chemical analyses directed towards a discovery of the caustic principle in *Duroia hirsuta*.



1 and 2, habit, approximately $\frac{1}{2} \times$. 3, flower, approximately $1\frac{1}{4} \times$.

This small tree, known throughout eastern Colombia as *solimán*, is believed by the Indians to "poison" other plants. It is found usually in colonies of up to twenty individuals in the forest, and invariably nothing grows underneath the tree, except perhaps *Selaginella* (see photograph, Plate XVIII, lower figure, in Bot. Mus. Leaf., Harvard Univ. 15 (1951)). The natives explain this curious ecological phenomenon of the absence of vegetation by saying that the roots of *Duroia hirsuta* "poison" the other plants. The real reason may be connected with the presence in *Duroia hirsuta* of swollen internodes which are always inhabited by ants.

Duroia kotchubaeoides *Steyermark* in Mem. N. Y. Bot. Gard. 12 (1965) 201.

COLOMBIA: Comisaría del Vaupés, Río Guainía, Puerto Colombia (opposite Venezuelan town of Maroa) and vicinity. Alt. about 800-850 ft. "Small tree. Flowers white." October 31–November 2, 1952. *R. E. Schultes, R. E. D. Baker et I. Cabrera 18211*.

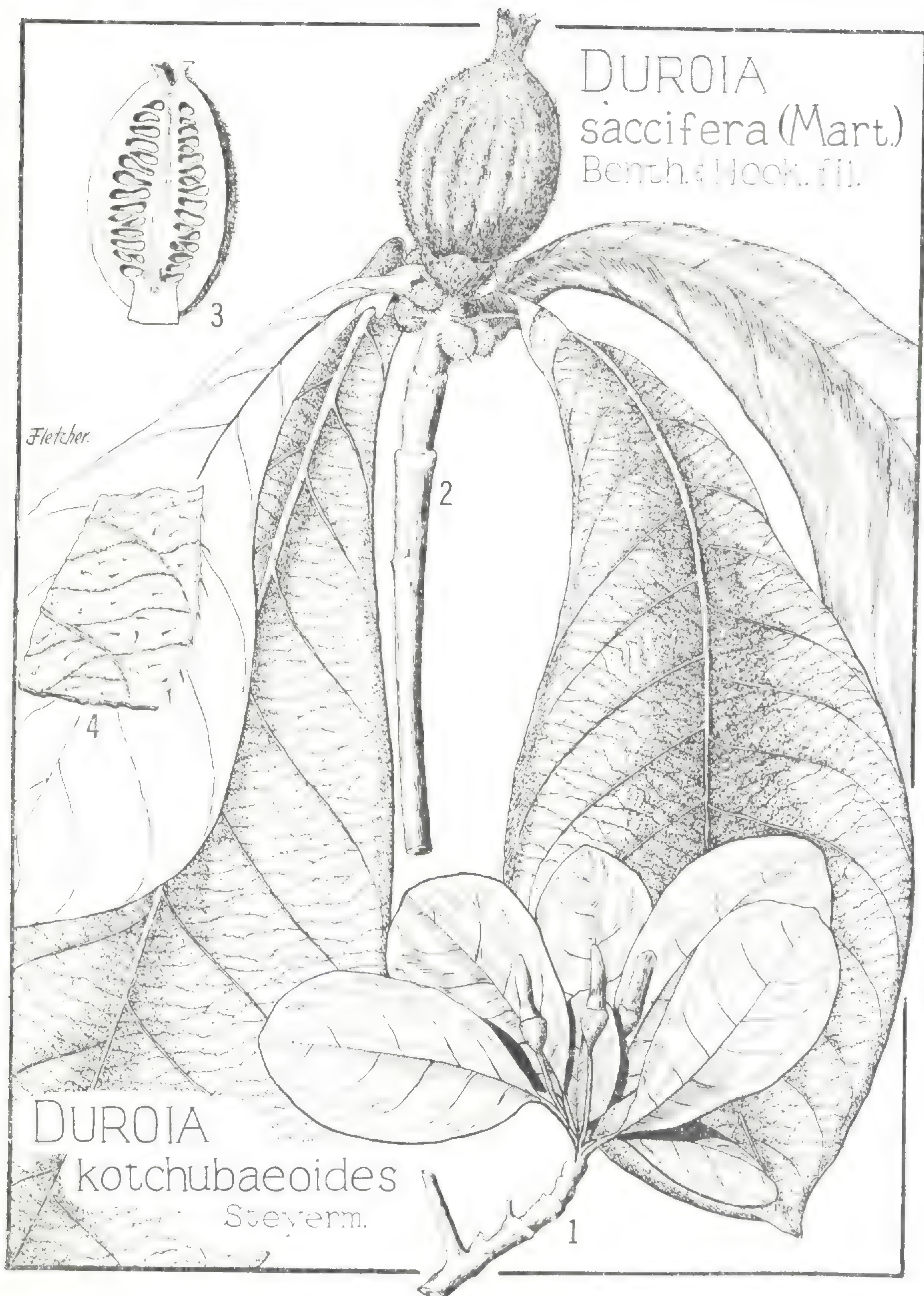
Amongst the inhabitants of the Río Guainía, the seeds of *Duroia kotchubaeoides* are held to be poisonous when eaten.

Schultes, Baker et Cabrera 18211 is the type collection of this curious species. It is known only from one other collection made from the upper Orinoco in Venezuela. The species appears to be a restricted endemic.

Duroia petiolaris (*Spr.*) *Hooker fil.* ex K. Schumann in Martius Fl. Bras. 6, pt. 6 (1889) 364.

COLOMBIA: Comisaría del Amazonas, Trapecio Amazónico, Río Loretoyacu. Alt. about 100 m. "Bush. Flowers white." October, 1945. *R. E. Schultes 6727*.—November 2, 1946. *G. A. Black et R. E. Schultes 46-295*.

The Tikuna Indians and the Brazilian rubber tappers of the Trapecio Amazónico assert that the seeds of this bush or small tree are extremely dangerous when eaten.



1 and 2, habit, approximately $\frac{1}{2} \times$. 3, fruit dissected, approximately $\frac{1}{2} \times$.
4, section of leaf greatly enlarged.

***Duroia saccifera* (Mart.) Hooker fil. ex K. Schumann** in Martius Fl. Bras. 6, pt. 6 (1889) 362, t. 146, fig. 1.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama and vicinity. "Tree 10 m. tall." March 26, 1952. *R.E. Schultes et I. Cabrera 16063*.

The natives in the middle course of the Río Apaporis state that the seeds of this small forest tree are toxic when ingested.

This collection extends the known range of *Duroia saccifera* into the Amazonian basin of Colombia; it has hitherto been known from Amazonian Brazil and the Río Guainía area of Venezuela.

***Duroia Sprucei* Rusby** Descr. New Sp. S. Am. Pl. (1920) 133.

COLOMBIA: Comisaría del Amazonas, Trapecio Amazónico, Río Loretoyacu. "Small tree. Flood bank." May, 1946. *R.E. Schultes 7127*. — Río Apaporis, Soratama, above mouth of Río Kananarí. June 18, 1951. *R.E. Schultes et I. Cabrera 12645*.

The seeds of this small tree have the reputation amongst the natives of the Río Apaporis of being poisonous to eat.

The type of *Duroia Sprucei* was collected in Venezuela. The collections cited above extend the known range of the species significantly southwestward.

***Psychotria* L.**

So far as the available chemical literature is concerned, there is little if any indication that the seeds and fruits of species of *Psychotria* would be toxic when ingested by man. Reports to this effect, however, are so frequent and are scattered over such a wide area that phytochemical studies based upon these ethnobotanical observations are justified.



1, habit, approximately $\frac{1}{2} \times$. 2, flower in bud, approximately $3\frac{1}{2} \times$. 3, flower opened, approximately $3\frac{1}{2} \times$.

Psychotria carthaginensis *Jacquin* Enum. Pl. Carib. (1760) 16.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Raudal Yaya-copi (La Playa) and vicinity. Quartzite base. Alt. about 800 ft. "Bush. Flowers white." April 15, 1952. *R.E. Schultes et I. Cabrera 16203*.—"Bush. Fruit red. On rocks of bank. Makuna name *wy-soo-dö*." August 18, 1952. *Schultes et Cabrera 16890*.

The Makuna Indians assert that the fruits of this shrub, if eaten, cause a poisoning that results in several days of weakness, fevers, nausea and disturbed vision.

Psychotria involucrata *Stearce* Prodr. Veg. Ind. Occ. (1788) 45.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Leticia and vicinity. September 1946. *R.E. Schultes 8231*.—Río Apaporis, Soratama, between Río Pacoa and Río Kananarí. "Bush, Highland." August 20, 1946. *R.E. Schultes et I. Cabrera 13629*.

The Tikuna Indians of the Leticia region and the Makunas of the Río Apaporis both consider the fruits of *Psychotria involucrata* poisonous when ingested.

Psychotria nudiceps *Standley* in Field Mus. Publ. Bot. 8 (1931) 378.

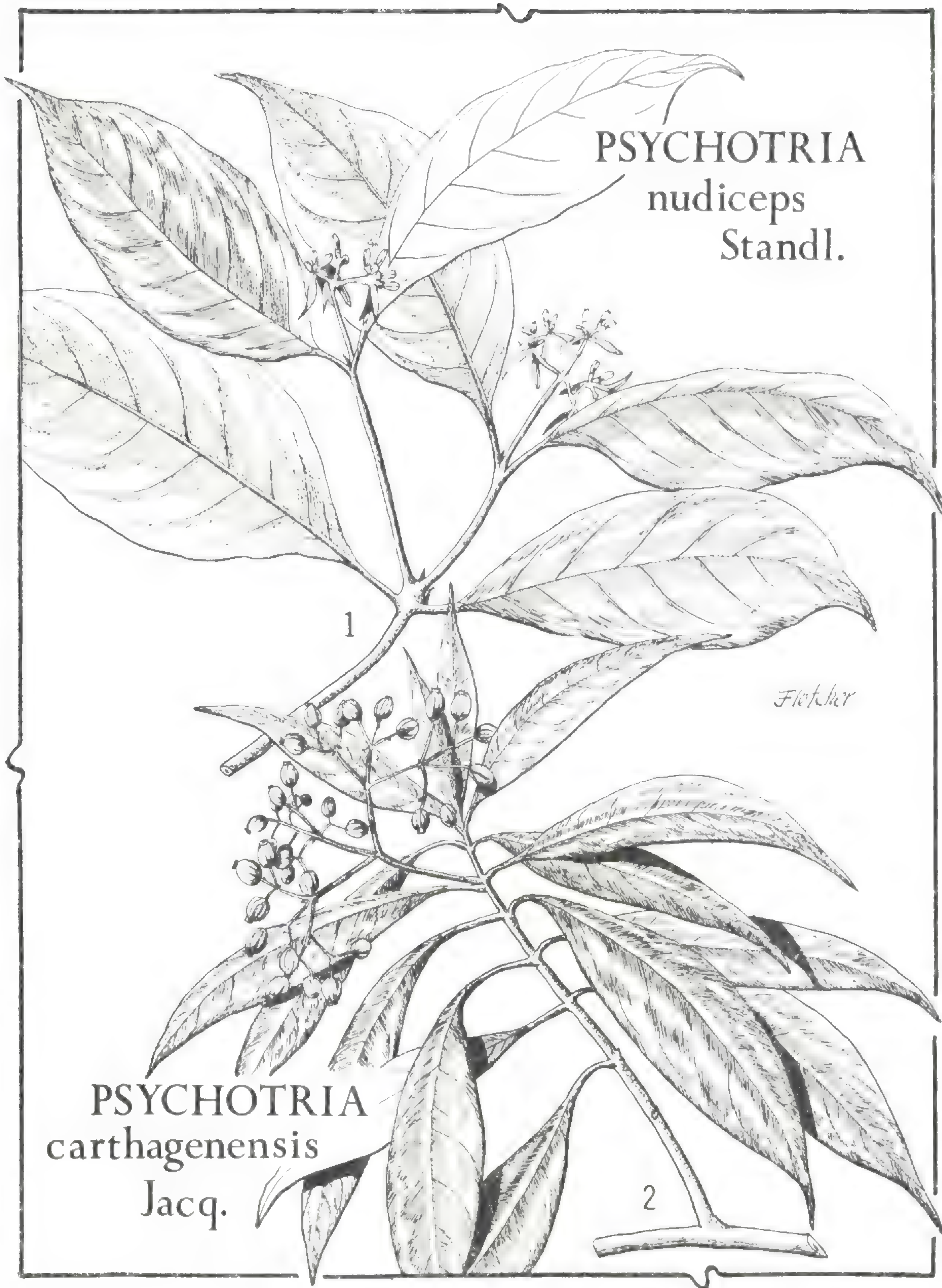
COLOMBIA: Comisaría del Amazonas, Trapecio Amazónico, Río Loretoyacu. October 1946. *R.E. Schultes 8408*.

It is a commonly accepted belief amongst the rubber tappers in this part of Colombia and adjacent Peru and Brazil that the fruits of *Psychotria nudiceps* are toxic when eaten.

Psychotria psychotriaefolia (*Seem.*) *Standley* in Contrib. U.S. Nat. Herb. 18 (1916) 133.

COLOMBIA: Comisaría del Putumayo, Mocoa and vicinity. "Leaves used with yajé." No date. *C. Naranjo s.n.*

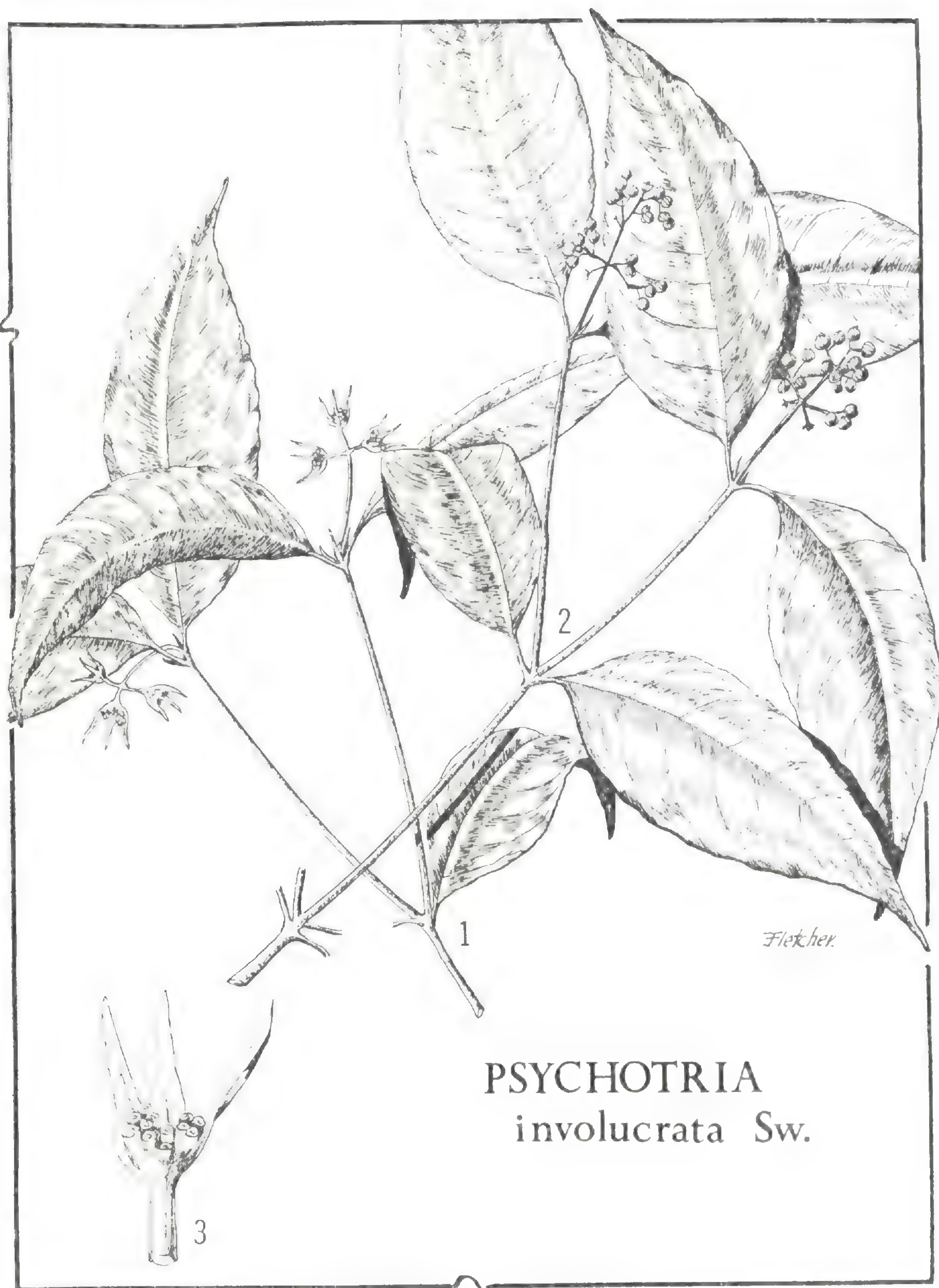
ECUADOR: Provincia del Napo, Río Aguarico, Dureno. Alt. about 800 ft. "Area near river and flood region. Shrub leaves and fruit used in preparation of the yajé narcotic as an admixture with *Banisteriopsis*." Alt. 800 ft. May 29, 1966. *H.V. Pinkley 225; 235*.



PSYCHOTRIA
nudiceps
Standl.

PSYCHOTRIA
carthagenensis
Jacq.

1 and 2, habit, approximately $\frac{1}{2}$ in.



PSYCHOTRIA
involucrata Sw.

1 and 2, habit, approximately $\frac{1}{2} \times$. 3, dried inflorescence, approximately $3\frac{1}{2} \times$.

PSYCHOTRIA
psychotriaefolia

(Seem.) Standl.



.I.

Habit, approximately natural size. Flower, approximately 5 ×. Dissected corolla, approximately 5 ×. Fruit, approximately 4 ×. Cross section of fruit, approximately 4 $\frac{1}{4}$ ×.

The earliest report of the use of a *Psychotria* as an additive to "fortify" the hallucinogenic yajé drink prepared basically from *Banisteriopsis Caapi* or *B. inebrians* was made in 1967 (Schultes, R. E. in Efron (ed.) "Ethnopharmacologic search for psychoactive drugs" (1967) 51). At that time, the identification could be made only to genus. Now, as a result of the field work of Mr. Pinkley amongst the Kofán Indians, it is possible to assign the species with certainty to *Psychotria psychotriaefolia*. Pinkley has, furthermore, been able to determine the sterile collection *Naranjo s.n.* to this species.

In the morning, after one of the all-night yajé-sessions which he attended amongst the Kofáns, Pinkley found, in the dregs at the bottom of the clay pot which had held the narcotic drink, a sediment containing leaves of *Banisteriopsis* and small rubiaceous fruits. These dregs might not have attracted the notice of an untrained observer. Since, however, Pinkley was especially interested in the complexities of yajé-preparation, these specimens raised his curiosity and, pursuing the problem ethnobotanically, he established the fact that *Psychotria psychotriaefolia* is not an uncommonly used additive in this region.

The Kofáns call *Psychotria psychotriaefolia* by the name *o-pri-to*. One of Pinkley's interesting observations indicates that these Indians refer to the "heavenly people", with whom they commune during the yajé intoxication, by the same term *o-pri-to*. He further reports that Mr. M. B. Borman, a missionary-linguist studying the Kofán language, states in a letter that both *Banisteriopsis Rusbyana* and *Psychotria psychotriaefolia* are added to the yajé drink prepared from *B. Caapi* to "increase the visions and make them of longer duration".

These observations serve to emphasize long felt urgency for a thorough chemical study of *Psychotria* and very closely related genera, such as *Palicourea*.

The collections *Pinkley 225* and *235* were identified by Dr. John D. Dwyer of the Missouri Botanical Garden.

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TREE DATURA DRUGS OF THE COLOMBIAN SIBUNDOY¹

BY
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IN southernmost Colombia high on the eastern flank of the Andean cordillera lies a small and isolated montane basin, the Valley of Sibundoy (Plate XLVIII). Several thousand Kamsá-speaking Sibundoy and three Inga-speaking groups have inhabited the Valley for several centuries, perhaps for much longer.³ The collapsing agricultural terraces clearly visible at many places on the valley sides indicate a populous pre-hispanic occupation, and the Sibundoy believe that their ancestors have lived in the Valley from very early times. As yet, however, there is no evidence linking the early terrace builders with the Sibundoy or with any other native group in southern Colombia.

Despite the apparent isolation of the Valley of Sibundoy, the natives have probably always been in contact with a diversity of other aboriginals. Today, as in the Sixteenth Century, there are three trails leading out of the Valley to the east, west and north. Two of these have recently been supplanted, for a road now connects the highland capital of Pasto twenty miles to the west

¹ Received for publication January, 1968.

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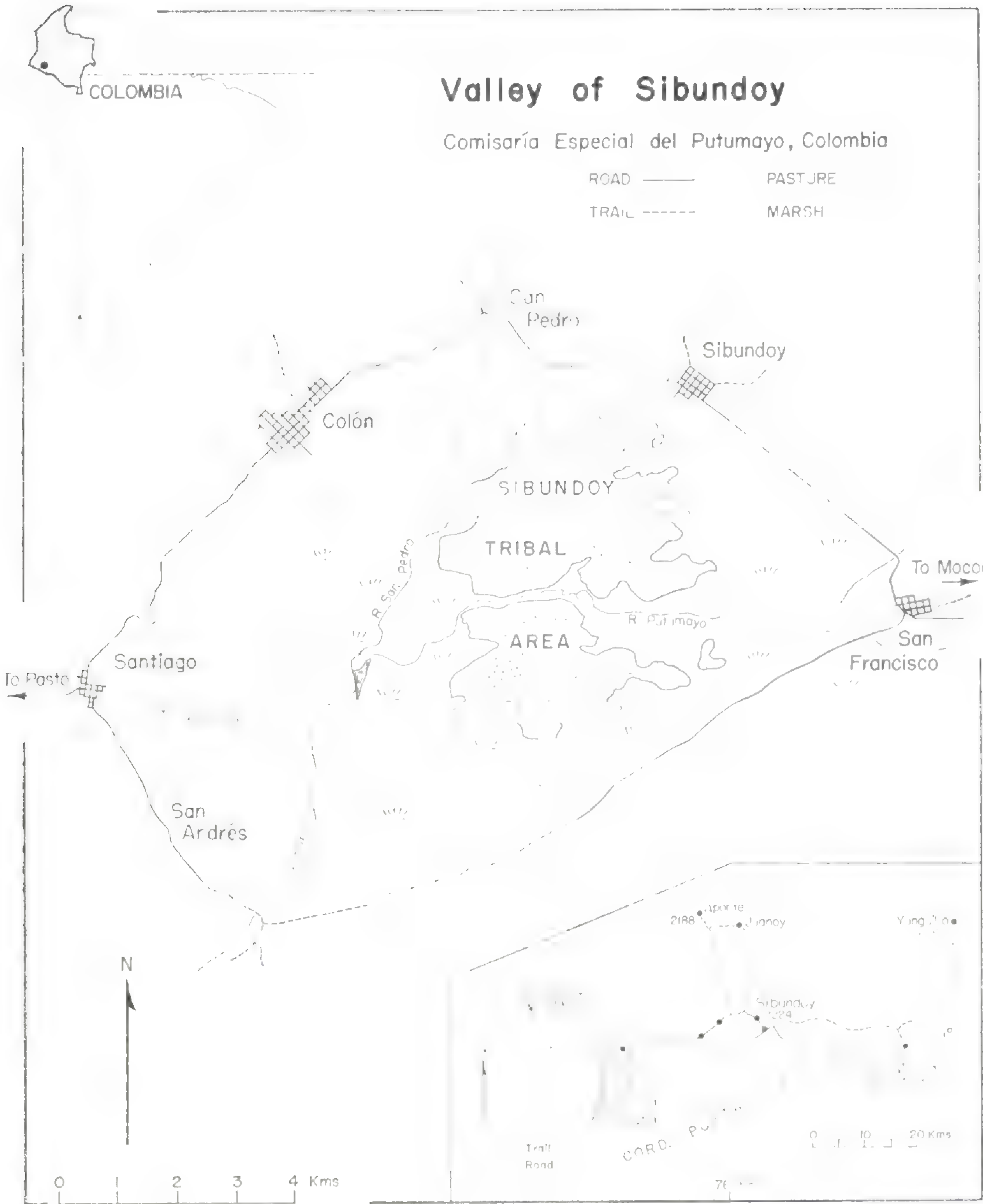
³ Inga is one of the northernmost Quechua dialects (9, 24).

with Mocoa in the eastern lowlands. The third, and shortest trail, connecting the Valley with the Río Juanambú drainage to the north, is probably little changed from 1801 when Humboldt and Bonpland traversed it twice, or from 1541 when Hernán Pérez de Quesada fled homeward along it from his wretched search for El Dorado.

During the long period of relative isolation, a great variety of curious cultivated plants were brought into the Valley. Some are of scant importance today and may never have enjoyed a wide appreciation among the Valley's inhabitants. Others, the predominant food, medicinal and narcotic plants, have come to assume very great importance in the economic and social life of the natives. Certain plants, known nowhere else, have evolved in the Valley under the influences of cultivation. Such has come to pass with the tree *Datura* drugs.

The genus *Datura* consists of eight to twelve herbaceous species (2, 3, 28), with their centre of diversity in Mexico and southwestern United States; and three or more (7) to fourteen (28) arborescent species centered in the northern Andes. In the absence of a modern and comprehensive revision of the genus, Safford's account of 1921 has been widely accepted. However, were we to continue employing his species concept today, the diversity of herbarium material available now would allow us to define thirty or more "species" of tree *Daturas* (sect. *Brugmansia*) alone. Recently, I have pointed out that almost all tree *Daturas* belong to one of three species and that the few remaining plants are probably hybrid or aberrant individuals (7). The variability expressed in the tree *Daturas* as a group has been enhanced through their cultivation by many native peoples; in fact, their absence from any natural vegetation implies that their recent evolution has taken place entirely under man's influences.

PLATE XLVIII



Valley of Sibundoy, showing the area inhabited today by the Sibundoy Indians. (Areas at the western and southwestern margins of the Valley inhabited by Colón, Santiagueño and Sanandreseño Indians are omitted.)

In the Valley of Sibundoy, most of the *Daturas* belong to the species *Datura candida* (Pers.) Saff., though *D. sanguinea* R. & P. is also present. They are much planted by the natives for ornament in hedge rows, in house yards and in the multi-purpose gardens: and the abundance of huge, white flowers which appear four times annually make them the principal visual focal point everywhere. Containing atropine and hyoscyamine, these *borracheras* ('inebriants') have been used variously by the natives both as psychotropic and medicinal preparations. While one of the cultivars, 'Buyés', is frequently seen throughout the inhabited parts of the Valley, most of the cultivars are encountered only very infrequently. So far as I am aware, the unique *Daturas* of the Valley were not known to outsiders until Hernándo García-Barriga found them in 1935.

Frequent suggestions that the Sibundoy tree *Daturas* are infected by viruses has focused attention on this as a major cause of the peculiar leaves by which several of the cultivars are recognized (3, 22, 35, 36). However, early in the course of my thirteen months of observations in the Valley in 1962-63, I realized that each cultivar is genetically distinct, quite apart from the possible influence of viruses on the leaves. Differences among the cultivars which I believe to be genetic lie in the morphology of the flowers and fruit, in the incidence of chromosomal inversions and in the amount of aborted pollen. Some of the unique leaves are also reflections of genetic uniqueness and not of virus infection. In recognition of ethnomedical, pharmacologic, chemical and phytopathologic interest in the Sibundoy tree *Daturas*, an important objective of my study has been to understand their morphologic and cytologic variability, to distinguish among them, and to define them.

Variation in Datura candida ‘Buyés’

Most specimens of *Daturas* in the Valley of Sibundoy are called *buyés borrachera* by the Kamsá-speaking Sibundoy, or *D. candida* cv. *Buyés* as described below. They represent several, or possibly many, genetic lines, as evidenced by marked differences in the size and shape of the flowers. At the present time, however, the natives are little, if at all, aware of these variations, and they do not discriminate verbally within their concept of *buyés borrachera*. For later purposes of comparison, it will be helpful here to record the limits of variation of *D. candida* ‘*Buyés*’ in the Valley of Sibundoy. To this end, a representative sample of leaves and flowers was taken from twenty-eight trees scattered throughout the area of the Valley inhabited by the Sibundoy. With the addition of other collections, there are thirty-seven trees represented, to give an indication of the range of variability of this cultivar. Table I gives the range of variation in *D. candida* ‘*Buyés*’ for six of the eight characters found to be most useful in distinguishing the nine Sibundoy cultivars of *D. candida*.

TABLE I. Range of variation in *D. candida* ‘*Buyés*’ (meas. in mm.).

		median
Leaf ratio (W/L)	.346–.577	.460
Calyx length	85– 161	128
Corolla length	196– 293	252
Stamen length (including the adnation of filament to corolla)	132– 199	165
Anther length	30– 41	35
Pistil length	143– 212	175

The most conspicuous feature of these trees is certainly the brilliant white corolla, but despite this, its variation in size has no formal recognition among the Sibundoy. In many flowers, the edge of the corolla between the lobes is emarginate, but in some it is straight or well

rounded. Counts of aborted pollen in six plants ranged from 20.7 to 80.4 per cent.

D. candida 'Buyés' is scarcely distinguishable from many examples of *D. candida* in widely separated areas of tropical America. In the characters studied, its range of variation is less than that of the species as a whole. The rare Sibundoy cultivars of this species have never been found outside of the Valley of Sibundoy, and it is my assumption that they are all derived, at least in part, from *D. candida* 'Buyés'.⁴

Chromosome numbers

Heiser (16) found the chromosome number of *D. candida* as represented by the collection *Heiser 6119* (IND), to be $n=12$, and Barclay (2, 3) found $2n=24$ in *D. candida* 'Culebra' (Barclay & Schultes 286) and in *D. vulcanicola* A.S. Barclay.

Preparation of aceto-carmin stained microspore mother cells permitted observation of the chromosomes after 48-72 hours. The chromosome counts for each cultivar were made on either one or two plants as indicated by the voucher collection numbers in Table II. Seven of the nine *D. candida* cultivars were examined, and all were seen to have a chromosome complement of $n=12$. All counts were made after metaphase I, most at or following metaphase II. The data are summarized in Table II. Figure 1a, illustrates the chromosomes of *D. candida* 'Culebra'.

Twelve is the haploid chromosome number of *Datura sanguinea* R. & P. (7, 16), of "*D. suaveolens*" (15), and of all the herbaceous species of *Datura* (1).

⁴ I recently encountered a tree referable to *D. candida* 'Amarón' near Las Cruces in southernmost Nariño. Thus the question is raised as to whether this was brought from the Valley of Sibundoy, or whether it is part of an early population of plants from which one or more of the Sibundoy cultivars might have originated.

PLATE XLIX



Datura candida (Pers.) Saff. cv. Buyés. (Upper) A massive display of flowers. (Lower) Habit of the tree, growing in a cornfield.

TABLE II. Chromosome numbers of *D. candida* cultivars.

Cultivar	No. of cells during microsporogenesis with				Voucher collection*
	n=10	n=11	n=12	n=13	
'Buyés'	1	2	137	3	1117, 1266
'Ocre'	—	5	57	—	1267
'Biangán'	1	3	43	—	1431
'Amarón'	—	—	22	1	564
'Quinde'	1	1	30	—	1304, 1433
'Munchira'	1	3	46	1	1268
'Culebra'	—	6	122	5	1112, 1400

* On deposit at the Economic Herbarium of Oakes Ames, Harvard University, and the United States National Herbarium.

Anaphase bridges

In four cultivars of *D. candida*, the frequency of anaphase I bridges in pollen mother cells was recorded. The formation of the anaphase bridge leads to uneven distri-

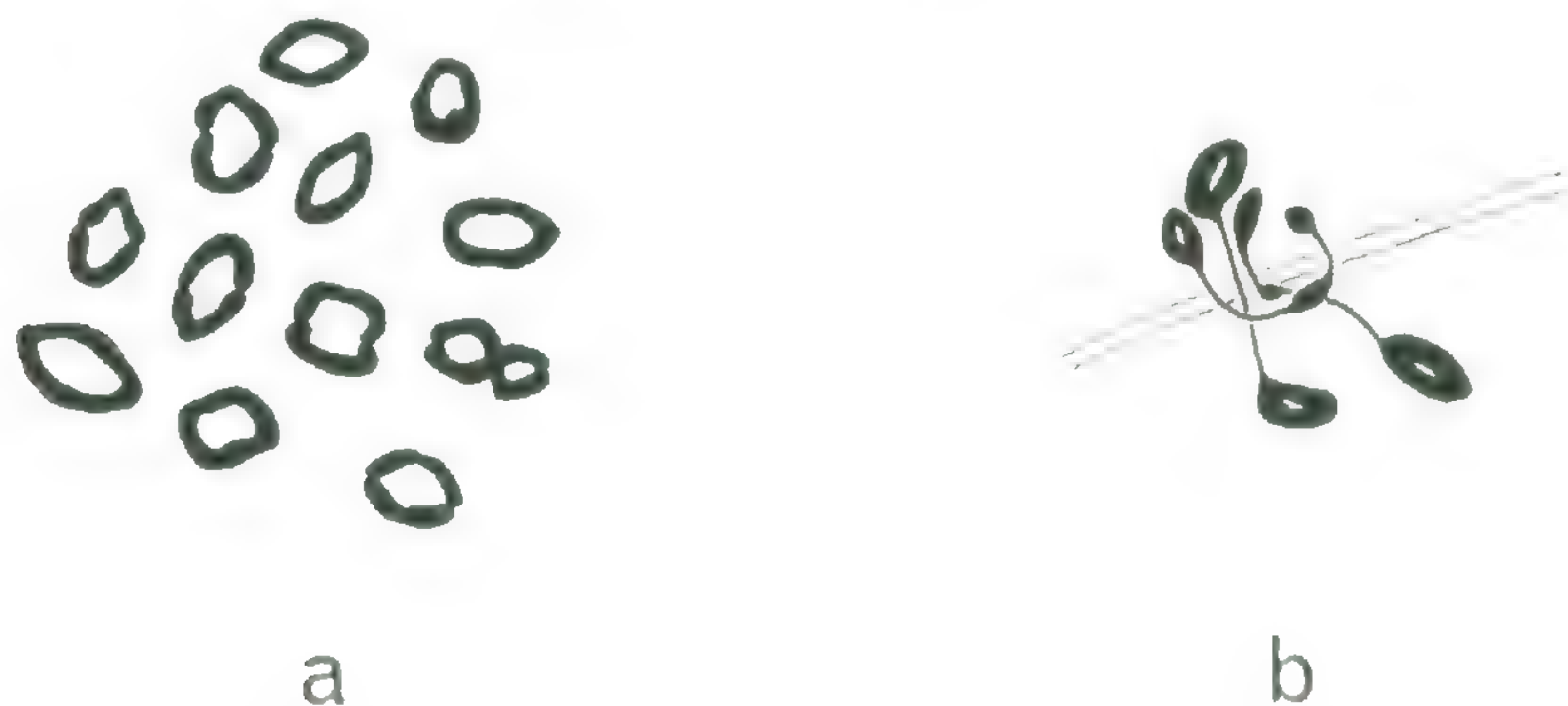


FIGURE 1. Chromosomes of *D. candida* 'Culebra'. (a) Metaphase I ($\times 500$). (b) Anaphase II bridges ($\times 2000$).

bution of chromosomal material between the first division meiotic products and to consequent imbalance in the four resulting microspores. Table III summarizes the data and includes frequencies of pollen abortion from Table IV for comparison.

In 'Ocre', no pollen mother cells were seen with more than one anaphase I bridge. 'Buyés' plants showed PMC's with one to four bridges, while in 'Culebra' there were up to nine bridges between first division nuclei. Figure 1b, illustrates an occurrence of anaphase

TABLE III. Anaphase I bridges formed during microsporogenesis in *D. candida* cultivars.

Cultivar	Total PMC's observed	No. PMC's with A I bridges	% PMC's with A I bridges	observed % abnormal pollen
'Buyés'	213	35	16.4	78.1*
'Ocre'	358	64	17.9	50.8
'Amarón'	1000	30	3.0	32.8
'Culebra'	537	97	16.9	83.3

* 'Buyés' trees *e* and *f* only.

bridges in 'Culebra'. The chromosomal irregularities leading to the formation of anaphase bridges are unknown. In many cases the bridges were accompanied by one or more fragments, implying that chromosomal inversions are responsible for some, but not all of the observed bridges.

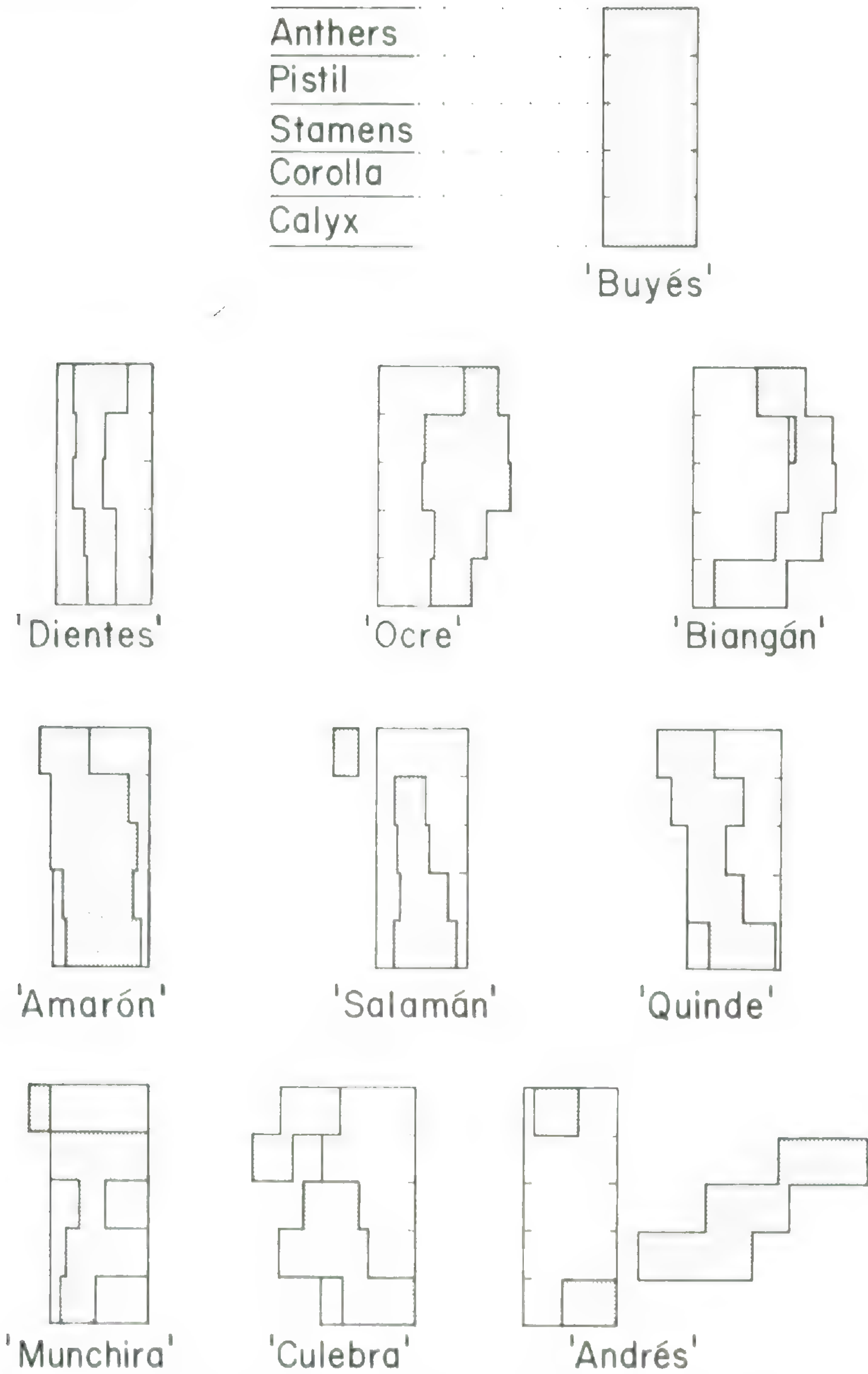
Pollen abortion

Preliminary examination of the pollen of *D. candida* 'Culebra' disclosed a predominance of small, either spherical or misshapen, spores among the large and well sculptured ones. I decided to investigate for comparative purposes the frequencies of such abnormal pollen in all of the *D. candida* cultivars. In all but two cases, a minimum of two widely separated trees was examined, one by myself and one by an assistant. The results of these examinations are recorded in Table IV.

It can be seen that the production of abnormal pollen ranges from a low of 5.7 per cent in 'Dientes' to a high of 83.3 per cent in 'Culebra'. As had been thought from purely morphological evidence, the cultivars 'Buyés' and 'Dientes' do not consist of a single clone each; with both groups there are widely differing capacities to produce normal pollen.

Some of the abnormal pollen may be accounted for by the inequality of meiotic products resulting from ana-

PLATE I



Ranges of variation in the lengths of five floral parts of *Datura* cultivars compared with the respective ranges of variation in *D. candida* 'Buyés'. The values for 'Buyés', from Table I, are standardized to a common size in the uppermost ideogram, and values for the other cultivars (cf. taxonomic treatment) are expressed in proportion to these.

TABLE IV. Frequencies of abnormal pollen in *D. candida* cultivars.

Cultivar	Tree	Total pollen observed		abnormal pollen		% abnormal pollen
'Buyés'	<i>a</i>	500		142		
	<i>b</i>	270	770	56	198	25.7
	<i>c</i>	500		208		
	<i>d</i>	500	1000	216	424	42.4
	<i>e</i>	700		535		
	<i>f</i>	500	1200	402	937	78.1
'Dientes'	<i>a</i>	700		39		
	<i>b</i>	529		29		
	<i>c</i>	500	1729	30	98	5.7
	<i>d</i>	500			129	25.8
	<i>e</i>	518			176	34.0
No. 1111	<i>a</i>	600			260	43.3
'Ocre'	<i>a</i>	608		308		
	<i>b</i>	500	1108	255	563	50.8
'Biangán'	<i>a</i>	800		472		
	<i>b</i>	564		370		
	<i>c</i>	500	1864	299	1141	61.2
'Amarón'	<i>a</i>	764		225		
	<i>b</i>	700	1464	255	480	32.8
'Salamán'	<i>a</i>		1546		173	11.2
'Quinde'	<i>a</i>	594		175		
	<i>b</i>	500		211		
	<i>c</i>	500		199		
	<i>d</i>	500	2094	180	765	36.5
'Munchira'	<i>a</i>		500		291	58.2
'Culebra'	<i>a</i>	615		506		
	<i>b</i>	490		416		
	<i>c</i>	250	1355	207	1129	83.3

phase bridges as noted above in Table III. The remainder might well be caused by the presence of genetic factors for pollen abortion; Blakeslee and his co-workers found thirty such factors in their extensive cultures of herbaceous *Daturas* (1).

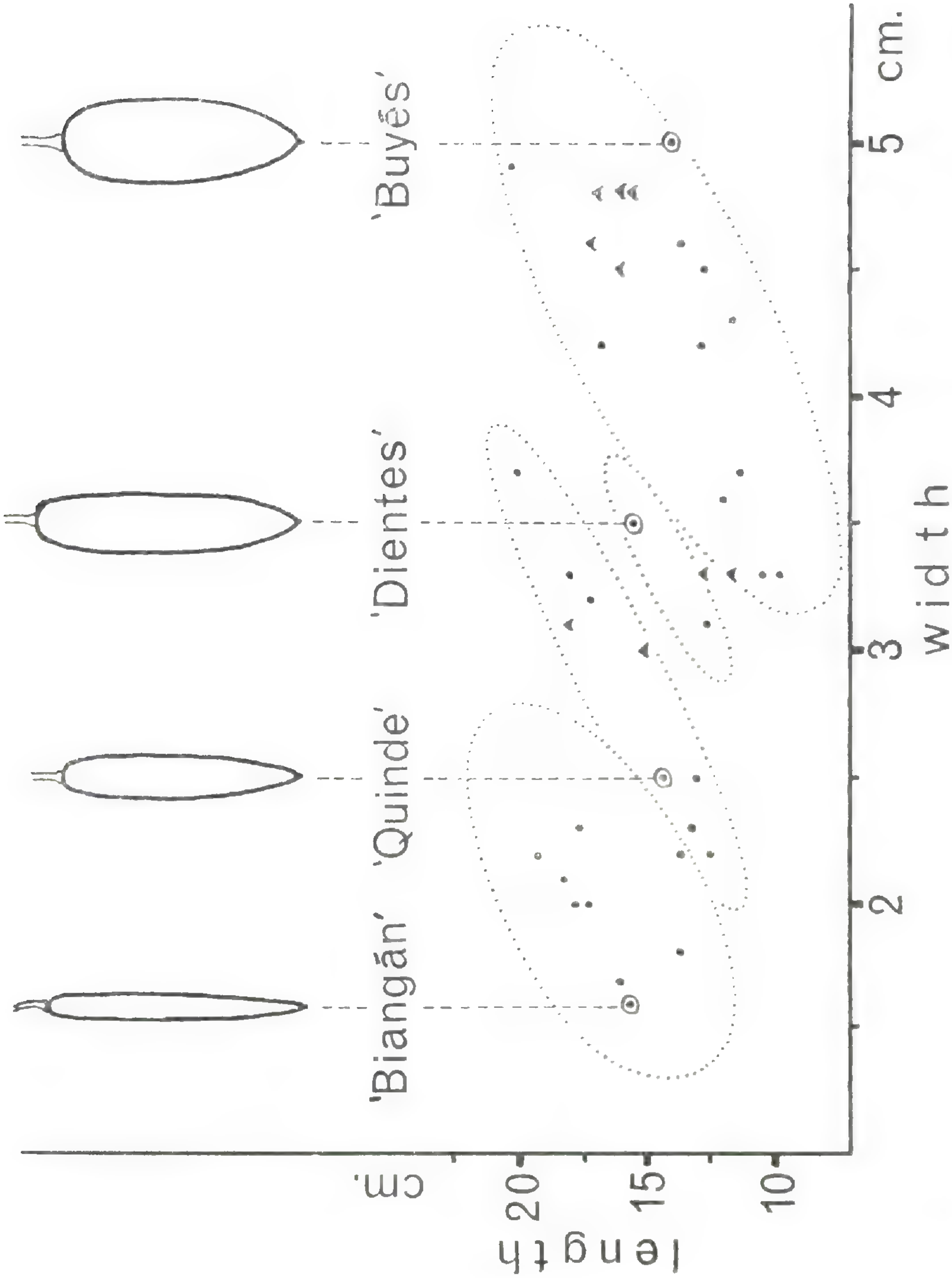
Flower variation among the Datura candida cultivars

All of the cultivars have markedly similar flowers, with the exception of the bizarre 'Culebra' which is discussed later. Nevertheless, each displays a distinctive range of variation in the length of the several floral parts. Plate I compares nine of the cultivars according to the lengths of five of their floral parts. It is evident that with but few exceptions the ranges of variation of each cultivar are either wholly within, or largely overlapping, those of *D. candida* 'Buyés'. This strongly suggests that most of the cultivars were selected from the large and variable population of *D. candida* 'Buyés'. It further suggests that the Sibundoy did not select and propagate new forms (cultivars) characterized by floral differences, but, as we shall see below, they selected leaf differences for preferential maintenance as clones.

Fruit variation

Most of the fruits found in prolonged searching throughout the Valley were on 'Buyés' and 'Amarón' trees which are by far the most numerous. Some fruits were also seen and collected on 'Dientes', 'Quinde' and 'Biangán' trees; the remainder of the *D. candida* cultivars are believed by the natives never to form fruit. The indehiscent fruits eventually dry up, and the pericarp disintegrates slowly; but the seeds are not released, and the dried fruit often remains on the tree for several months. Plate LI shows the variation in fruit size and shape among the five cultivars known (however rarely)

PLATE LI



Fruit variation in *D. candida* cultivars. The fruits, shown $\frac{1}{4}$ natural size, are from the following collections: 1162 ('Biangán'), 1121 ('Quinde'), 1447 ('Dientes') and 1117a (Buyés'). A—'Amarón', see text for explanation.

to produce fruit. Most of the nine 'Amarón' fruits collected fall within the 'Buyés' variation pattern; two are the same as 'Quinde'. A single 'Buyés' tree (*Bristol 1109, 1193*) has unusually long (11.7–24.7 cm.), more narrow fruits which are not included in Plate LI. Measurements were made on ripe fleshy fruits.

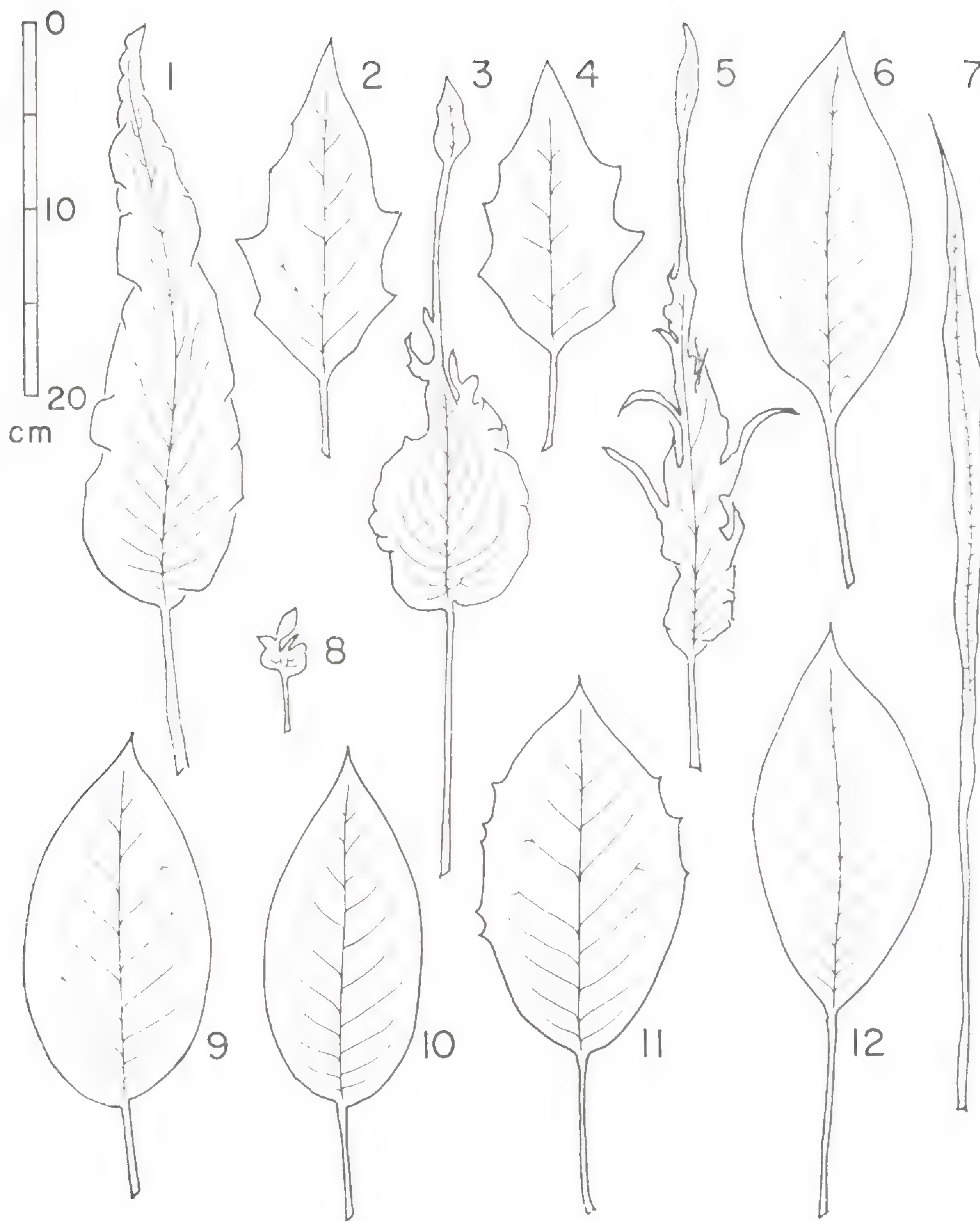
Leaf variation

Despite the highly conspicuous and attractive flowers of all the cultivars, the leaves are the centre of interest to the natives, to whom they are the structures of principal economic importance. Plate LII depicts a representative leaf of each cultivar. The striking malformation in four of the cultivars has led to statements that the plants are diseased, probably by viruses, or that they are " 'virus-races' " (3, 22, 35, 36).

Recently, Robert Kahn and R. Bartels have isolated a previously unknown virus from several of the cultivars, including 'Buyés' which never has erose or otherwise malformed leaves (21). These investigators have named the virus Colombia Datura Virus (CDV) and report that its symptoms in *Datura* are leaf distortion, mottling or yellowing, but that sometimes there are no symptoms. Leaves of the common *D. candida* 'Buyés' in the Valley of Sibundoy are never distorted, and mottling and yellowing, if present, are rare.

It seems probable that there is no direct causative relationship between CDV and leaf shape in the *D. candida* cultivars. At the same time, the genetic control of leaf shape is enigmatic, for careful examination of the irregularly leaved cultivars will disclose on every plant a few small to medium sized ovate and entire leaves, as in 'Buyés'. These leaves invariably occur on one or two branches which are growing more rapidly than all others on the plant. Given this exception, it is tempting to pos-

PLATE LII



Representative leaves of all Sibundoy *Datura* cultivars, with collection numbers indicated: 1, 'Amarón', 564; 2, 'Guamuco', 1420; 3, 'Salamán', 1432; 4, 'Sangre', 1309; 5, 'Quinde', 1333; 6, 'Andrés', 1314; 7, 'Culebra', 1112; 8, 'Munchira', 1268; 9, 'Buyés', 1388; 10, 'Biangán', 890; 11, 'Dientes', 1447; 12, 'Ocre', 1267.

tulate that the highly irregular formation of the leaves is caused by a critical concentration of a diffusable substance, and that in the exceptional cases of very vigorously growing stem apices the critical level of concentration is not reached. Such a substance might be viral or hormonal in nature. That the natives find the smallest, most malformed leaves the most toxic suggests that even the tropane alkaloids should not be ruled out of consideration as possible inhibitors of regular leaf development. As Robert Kahn has suggested to me, grafting experiments should help to clarify the development of the various leaf shapes.

Seedlings

Through thirteen months of constant observation of the *Datura* cultivars in the Valley of Sibundoy, no seedling tree was seen. It has been possible, however, to grow healthy seedlings of three clones, 'Buyés', 'Amarón' and 'Quinde', in the greenhouses of the Biological Laboratories of Harvard University. The seedlings within each cultivar are not uniform. Seeds collected from *D. candida* 'Quinde' trees have produced seedlings the leaves of which resemble 'Dientes' (1596, 1611; ECON) as well as 'Quinde' (1607; ECON). Seedling variation from a single 'Quinde' fruit includes both 'Quinde' and 'Dientes' types (1608; ECON), suggesting that a 'Dientes' tree may have been the pollen parent.

'Quinde' seedlings exhibit the same failure to form 'Quinde'-type leaves on a very vigorously growing stem that was observed on mature trees in the Valley of Sibundoy. As the growth rate of the seedlings slows somewhat, these same stems that grew vigorously produce typical 'Quinde'-type leaves. Assays of these seed grown 'Quinde'-type leaves for the presence of mechanically transmittable virus by Robert Kahn (pers. comm.) have

been negative, as would ordinarily be expected. Thus the formation of 'Quinde'-type leaves by apparently healthy seedlings implies that the typical leaves of 'Quinde' trees are formed independently of the virus (CDV) infecting them.

One may compare the successive occurrence of differently shaped leaves to the widely encountered phenomenon of juvenility, but in so doing it must be noted that only four of the *D. candida* cultivars are involved, while the other five are not. I have not seen any descriptions of juvenile leaves in the genus *Datura*.

Blakeslee found a variant of *D. Stramonium* with a leaf similar but not identical to that of 'Quinde' (1). He named these 'Quercina' and soon established that their unusual leaf shape depended upon a single recessive gene. Curiously, he also discovered that the juices of the plant would transmit the characteristic to normal *D. Stramonium*, and he believed that the Quercina effect was caused both by a gene and by a virus. Further studies of the supposed virus have not been undertaken to my knowledge.

Geographical centre of diversity

More variation in *Datura candida* is found in the Valley of Sibundoy than is known at any other locality. Such a centre of diversity in an isolated valley apparently inhabited by ancient agriculturists suggests the possibility of domestication and early evolution here. However, that the Valley of Sibundoy is *not* the centre of origin of any tree *Datura* is attested by the absence of all *Datura* spp., and any solanaceous plants resembling them, in the non-cultivated flora. Were the Valley the site of domestication, we would expect to find some plants capable of self-reproduction, either sexually or asexually, and not wholly dependent upon man for survival. Evidently one or more clones of *D. candida* were brought into the

Valley at some remote time. Today, *D. candida* is found neither in the eastern lowlands, nor in the western highlands around Pasto, but several plants of *D. candida* 'Buyés' (*Bristol 1185*) were seen in the upper Río Juanambú drainage to the north. It may be postulated that *D. candida* was introduced to the Valley of Sibundoy via the trail from the Juanambú, and that following one or more such introductions the Valley became a centre of diversity.

Propagation

All of the *Datura* cultivars in the Valley of Sibundoy are propagated exclusively by man through large cuttings. During the annual clearing of the gardens in preparation for the planting of maize and beans, some of the many trees and shrubs in the gardens are pruned, pollarded or even cut back to the ground. The removal of branches from a *Datura* plant to permit more planting space is the usual occasion for propagation. A branch measuring half a meter or more is simply thrust into the loose sandy soil and given no further attention. Occasionally, a more methodical planting is undertaken when the branches are cut into fairly uniform pieces and planted out in a row as a kind of hedge along the edge of a garden. These plants will be weeded during the general garden weedings four times a year.

Tree *Datura* branches at different stages of maturity differ in their capacity to root easily from cuttings. All of the leaves are borne on herbaceous stems which are only tardily lignified. Occasionally, usually after heavy pruning or pollarding, one or more stems grow up with unusual vigor and often reach a diameter twice that of a normal stem. The lignified part of normal stems is the least capable of forming roots under casual treatment; but the occasional, thick and uncommonly vigorous stems

develop roots quickly and abundantly when cuttings are taken from the region which has begun to lignify. One clone, 'Munchira', is difficult to propagate, since its stems are typically undersized, and the few stunted plants in existence are only rarely cut back. When this is done, however, the expected growth of thick, vigorous shoots appears, and cuttings made from these root easily.

Abundance of Datura cultivars

In the Valley of Sibundoy, tree *Daturas* are more conspicuous and more abundant than at many other localities in southern Colombia. At least 60 per cent of the trees are *D. candida* 'Buyés', while another 30 per cent are *D. candida* 'Dientes' and 'Amarón'. All of the economically more important cultivars comprise the remaining 10 per cent. Table V indicates the estimated number of individuals of each cultivar in 1963, and emphasizes the rarity of many.

TABLE V. Estimated number of individuals of *Datura* cultivars in the Valley of Sibundoy in 1963.

ca. 1000	'Buyés'
ca. 300	'Dientes'
ca. 200	'Amarón'
less than 40	'Culebra'
	'Quinde'
	'Guamuco'
	'Biangán'
less than 20	'Munchira'
	'Sangre'
less than 10	'Andrés'
	'Ocre'
	'Salamán'

It is difficult to judge whether the relative scarcity of nine of the cultivars reflects their more recent appearance in cultivation, or the degree of jealousy with which they

are guarded from other potential owners. A medicine-man once stated that he could not afford to be seen near an unusual *Datura* in another man's garden (6). If such a prohibition is general among the Sibundoy, the tree *Daturas*, however useful, may be increasing at an extremely slow rate. The two cultivars thought by the Sibundoy to be the most toxic, *D. candida* 'Munchira' and 'Salamán', are among the least abundant.

Common names

The three linguistic groups of people in the Valley of Sibundoy agree in grouping all the *Datura* cultivars in the Spanish term *borrachera* ('inebriant').⁵ However, the Sibundoy believe this to be a Kamsá morpheme, not a loan word. Ten of the twelve cultivars are discriminated verbally, but because of the rarity of several, very few Sibundoy can name all ten. To name all ten, one must draw words from three languages, but because of generalized borrowing among these three, a speaker may not be aware of this. Kamsá lacks names for three cultivars, Inga for two. Table VI gives the common names recorded in 1962-63. A full account of the vernacular names is given with the taxonomic treatment of the cultivars. My capabilities did not permit the most precise form of phonetic records. Accurate pronunciation will be approximated most frequently within the Spanish, not the English, phonetic framework. An exception is *bui-ish* which I have written here *buyés*, conforming with the notation of Juajibioy (19).

Economic importance

Both my own investigations and the reports of others indicate that the *Daturas* are used about equally for

⁵ Several non-solanaceous, non-psychotropic plants are also called *borrachera*, e.g., *Iresine celosia* L., *I. herbstii* Hook.f., and other unidentified plants.

TABLE VI. Common names employed in the Valley of Sibundoy for *Datura* cultivars.

Common name	Language	Scientific name
1. <i>Amarón</i> *	Spanish	<i>D. candida</i> 'Amarón'
2. <i>Andaqui</i>	Inga	<i>Datura</i> 'Andrés'
3. <i>Biangán</i> *	Inga	<i>D. candida</i> 'Biangán'
4. <i>Borrachera</i> ‡	Kamsá	<i>D. candida</i> ;
	(Spanish)	<i>D. candida</i> 'Buyès', 'Dientes'
5. <i>Borrachera de agua</i>	Spanish	<i>D. candida</i> 'Buyés', 'Dientes'
6. <i>Buyés</i> *	Kamsá	<i>D. candida</i> 'Buyés', 'Dientes'
7. <i>Cari</i>	Inga	<i>D. candida</i> 'Quinde'
8. <i>Cucu</i>	Inga	<i>D. candida</i> 'Amarón'
9. <i>Culebra</i> *	Spanish	<i>D. candida</i> 'Culebra'
10. <i>Chontaruco</i>	Inga	<i>D. candida</i> 'Biangán'
11. <i>Danta</i>	Inga	<i>D. candida</i> 'Biangán'
12. <i>Floripondio</i>	Spanish	<i>D. candida</i> 'Buyés', 'Dientes'
13. <i>Guamuco</i> *	?	<i>D. sanguinea</i> 'Guamuco', 'Sangre'
14. <i>Guamuco blanco</i>	Spanish	<i>D. candida</i> 'Buyés', 'Dientes'
15. <i>Guamuco floripundo</i>	?	<i>D. sanguinea</i> 'Guamuco', 'Sangre'
16. <i>Ngunsiana</i>	Kamsá	<i>D. candida</i> 'Quinde'
17. <i>Lengua de tigre</i>	Spanish	<i>D. candida</i> 'Culebra'
18. <i>Mutscuai</i>	Kamsá	<i>D. candida</i> 'Culebra'
19. <i>Munchira</i> *	Inga	<i>D. candida</i> 'Munchira'
20. <i>Quinde</i> *	Inga	<i>D. candida</i> 'Quinde'
21. <i>Salamán</i> *	?	<i>D. candida</i> 'Salamán'
22. <i>Salamanga</i>	?	<i>D. candida</i> 'Salamán'
23. <i>Salvanje</i>	Kamsá	<i>D. candida</i> 'Salamán'

* Most frequently employed while speaking Spanish.

‡ *Borrachera* is usually 'tree *Datura*'. When the context is not clear it follows the cultivar name, e.g., *culebra borrachera* 'snake tree *Datura*'.

medicinal and for psychotropic preparations by the Sibundoy. This information is summarized in Table VII. Several of the cultivars are relatively unimportant, but to four attaches an aura of great respect for their power to alter consciousness drastically — even to cause death.

Most of the Sibundoy indicate a genuine interest in the *borracheras*, but individuals vary greatly in the ex-

Table 7. Uses of Datura cultivars. (x indicates one report*.)

Cultivar	Use							
	Internal				External			
	Psychotropic	Poison	Medicine					
			Vermifuge	Other	Antirheumatic	Suppurant	Erisipelas	Common Cold
1. Guamuco } 2. Sangre } 3. Buyés } 4. Dientes } 5. Ocre 6. Biangán 7. Amarón 8. Salamán 9. Quinde 10. Munchira 11. Culebra 12. Andrés	 x x x 1 x 2 x x x x x x x x x x x x x 3 x 4 x 5,6 x 7 x 8 x 9 x 10 x 11 x	 x 5 x 8	 x x 3 x 8	 x 1 x x x x x 8	 x x x x x x 8 x 8 x 9	 x x 8	 x x 6 x 8 x 9	

* "Report" here means one of the following: (a) one Sibundoy's personal report to me, (b) one herbarium specimen notation by another botanist, (c) one primary literature statement not duplicating a herbarium notation. b and c are footnoted.

1. *Idrobo 2231* (COL)

2. (38)

3. *Idrobo 2223* (COL)

4. (20)

5. *Schultes 3256* (COL, ECON, GH)

6. (29)

7. *Schultes 20079* (GH)

8. (35)

9. *Idrobo 2221* (COL)

10. *Fernández 2641* (COL)

11. *Mora 1023* (COL)

tent of their knowledge. For example, very few, perhaps only the medicine-men, are able to name all the cultivars accorded recognition by the culture; but even some of these may be unaware of cv. Salamán. Many informants can provide names and some kind of information on four or five different *borracheras*. The “average” landowner may own several ‘Buyés’ trees but probably has no economically important cultivar. Both his knowledge and his curiosity extend beyond the *borracheras* in his own garden. Following is a summary of economic uses.

1. ‘Guamuco’—A poultice of the flowers, together with ‘Culebra’ leaves and the stems and leaves of *Phenax integrifolius* Wedd. is used to treat rheumatism. The leaves are sometimes heated and tied over swollen infections, or an infusion of the leaves may be used to bathe infections.
2. ‘Sangre’—Same as ‘Guamuco’.
3. ‘Buyés’—Leaves of this cultivar are sometimes powdered and applied topically with other drugs to relieve rheumatic pain.

One informant said he always uses the fruit of this at maize planting time. He plants a few fruits along with the maize in order to prevent grubs or other soil pests from eating the germinating seed. This interesting gesture to protect the crop can scarcely be a general practice, however, because fruiting is rare. This is the only use ever encountered for any *Datura* fruit or seed in the Valley of Sibundoy.

4. ‘Dientes’—Same as ‘Buyés’.
5. ‘Ocre’—No use encountered.
6. ‘Biangán’—The leaves and flowers can be ground

finely and mixed into a dog's food prior to a hunting expedition, supposedly to make the animal locate more game. The behavior of a dog so intoxicated would be most interesting to observe, but hunting is rarely practiced in the Valley today.

An herbarium specimen from Sibundoy (*Idrobo 2231*; COL) records this note on *biangán borrachero*: "Taken as a stimulant when feeling fatigue and also as an hallucinogen." I did not learn of these uses by the Sibundoy. However, one Sibundoy related how his three year old daughter ate part of some flowers of this near the house and became dizzy and incoherent, falling to the ground and shouting periodically for many hours thereafter.

Yepes (38) included this in his account of intoxicating plants used by a medicine-man from Santiago (not of the Sibundoy tribe).

7. 'Amarón'—The leaves of this cultivar are sometimes used as a suppurant and as an anti-rheumatic.
8. 'Salamán'—This cultivar is the rarest, being known only in one garden, and its owner considers it the most toxic of all the *Daturas*. He uses the leaves, along with those of 'Quinde' and 'Culebra' in an infusion for bathing rheumatic limbs and joints. He has also used both the leaves and flowers for their psychotropic effect, as described below.
9. 'Quinde'—This is the most widely known of the economically important cultivars. An infusion of the leaves is employed both as an anti-rheumatic and as a vermifuge, and the leaves are applied topically as a suppurant. The leaves and occasionally the flowers are used psychotropically, probably more often than any other Sibundoy *Datura* (cf. below).

10. 'Munchira'—The minute and highly toxic leaves are employed medicinally as an anti-rheumatic, emetic, carminative, vermifuge and to treat erysipelas. Their psychotropic use is described below.
11. 'Culebra'—This cultivar has received more attention from botanists because of its especially curious morphology, and because of its description by Schultes in 1955, as a distinct genus, *Methysticodendron*. Despite the numerous reports on its medicinal, and especially psychotropic, importance, my investigation showed it to be less important to the present day Sibundoy than either 'Quinde' or 'Munchira'. I found it used against *resfrio* ('colds,') and against erysipelas, and more often than other cultivars, against rheumatism.

Schultes reported the use of *culebra borrachera* in treating swollen joints, combating chills and fevers, and in divination, prophecy, therapy, and learning "witchcraft" (29).

Theilkuhl, who visited the Sibundoy in 1956, was also able to learn of the importance of this plant as a psychotropic drug, as well as medicinally in the form of poultices, "to combat rheumatism, swollen infections, muscle cramps, erysipelas, and in the form of baths, colds" (35).

12. 'Andrés'—One informant said he had used the flowers psychotropically.

Psychotropic use

Literature dealing with the Daturas of the Valley of Sibundoy has emphasized their importance as psychotropic, or mind affecting, drugs (27, 29, 30, 31, 32, 33, 36, 38). Writings based directly upon experience among the Sibundoy are those of Schultes (1955) and Theilkuhl

(unpublished thesis, 1957) dealing only with 'Culebra', and of Pedro Juajibioy (1960, MS.). Yepes interviewed Inga-speaking medicine-men travelling through Popayan to the north (38).

Because of the possibility that the Sibundoy learned the use of some of the *Datura* cultivars from the nearby Inga-speaking peoples of Santiago, Colón and San Andrés, it is well to include here the following information collected from some of their medicine-men (38):

Borracheras. (Daturas). They are characterized as '*calientes* (1) equal to fire.' They distinguish more toxic and less toxic species, and give preference to the latter for divinatory purposes. When they take them, they have an assistant accompany them because they produce furious intoxication beyond certain dosages.

Borrachera. 'Lengua de Tigre or Tinye' (2). In small quantity, it gives strength. Beginning by cooking three pairs of leaves or one flower, one progresses to larger dosages with time, and in this form it serves to make divination, diagnosis and witchcraft [*maleficio*].

Biangán borrachera. During the wane of the moon, 2 pairs of leaves are given to the dogs so that they will go out as hunters (3).

Danta borrachera. It is given to hunting dogs so that they may follow easily the trail of any animal (3).

(1) *Calientes* ('hot' plur.), medicines which "cure the diseases . . . produced by cold." (38).

(2) Identity unknown, but apparently referable to *D. candida* Saff.

(3) Apparently *D. candida* 'Biangán'.

The Sibundoy [Inga-speaking native of the Valley of Sibundoy, *not* a Sibundoy] knows intoxication with *borrachero* by the dryness of the throat and the dilatation of the pupil (38).

Schultes, who investigated the plants among the Sibundoy in 1942, 1946 and 1953, summarized his findings on the psychotropic aspects of *culebra borrachera* in these words (29):

This intoxication, resorted to by the witch-doctors only for very important or difficult cases of divination, prophecy or therapy, usually lasts for two full days and sometimes may persist for four—with a long period of complete lack of consciousness. Missionaries

who have been at work in the Valley of Sibundoy for more than a quarter of a century suspect that the death of one aged witch-doctor may have been due to an overdraft of this narcotic.

Smaller doses of the drug are administered to boys who are studying witchcraft. Certain of the medicine-men's secrets apparently are imparted only when the novitiate is "under the protection" of this narcotic.

Both Schultes' and Theilkuhl's descriptions of the method of preparation of the drug are nearly the same as that described below for the other cultivars.

Theilkuhl, after visiting the Sibundoy in 1956, wrote of this clever use of *culebra borrachera* (35):

. . . it is suspected that occasionally unscrupulous Indians use it as a 'burundanga', that is, to deprive outsiders of their senses and rob them.

It seems that the 'médicos' or 'curacas' take an aqueous maceration of the leaves to produce hallucinations, during which they say they see the solution of difficult cases of divination, prophecy or diagnosis. One of the 'médicos' questioned affirms that the 'culebra borrachera' is employed in a manner similar to that of 'yagé' [*Banisteriopsis* spp.; (6)], the focal point of Amazonian medical practice.

Yepes, Schultes and Theilkuhl use the words divination, prophecy, diagnosis and witchcraft in describing the psychotropic use of *Datura*, yet no Sibundoy I encountered stated such reasons for using any *Datura* drug. Nor has Haydée Seijas found these usages during more than one year of investigating Sibundoy ethnomedicine (pers. comm.). Most of those with whom I talked appeared to consider the drugs hallucinogens, but I failed to record precisely their statements. Had this been done by myself and the other observers, we might assess the psychological, as well as social, significance more accurately.

The Sibundoy observer, Pedro Juajibioy, has recorded five instances of intoxication with *Datura* among his acquaintances (20). In three cases, it is stated that the leaves were taken to cure disease: *agua blanca* ('white

water') and stomach ache. *Agua blanca* refers probably to gonorrhea (Seijas, pers. comm.). Only in one case does he mention the identity of the cultivar—'Munchira'. The following experience may be due to use of *D. candida* 'Culebra':

The first time I drank six leaves at night. I got drunk. I saw woods full of trees, people from somewhere else, animals, stumps, pastures full of all kinds of snakes that came up the slopes of the pasture all in green. They coiled to bite me. As the intoxication took greater hold of me, the house started to revolve against the world, and the same with the things in the house, etc. But the snakes stretched for the kill!

Such horrible hallucinations may be commonplace. The Sibundoy appear to have an instinctive fear of snakes, despite the supposed absence of poisonous ones in the Valley. One medicine-man who had never taken 'Culebra' thought that if he did he would see "ugly things, snakes".

Juajibioy (ibid.) gives another example which was surely entertaining for observers:

I took . . . only six leaves. I got drunk after an hour [and?] my vision went dim. During the day I saw unknown people duplicated—that is, one person in two men. I felt crazy. I started running, then took off my clothes, and ran around naked in the garden, and showered myself with the piles of dirty weeds left by the hired men who were working at that moment. I also insulted them freely. And I went about kissing several tree trunks thinking they were my fiancée. Later I took to writing letters. I went out to the pasture with a rope to catch a horse to ride, but it turned out to be a dog.

Despite these reports, I did not succeed in locating any native of the Valley who had employed *D. candida* 'Culebra' for its psychotropic action. One prominent medicine-man has in his garden eight plants of this clone, perhaps one quarter of all the plants extant in the Valley. While he regularly takes the psychotropic *Banisteriopsis* (6) and has tried several of the *Daturas*, he has not taken 'Culebra' and knows of no one who has done

so. Frequently natives do not specify which *borrachera* they refer to unless questioned, and outsiders may easily assume *culebra* is intended.

Seijas reports that *borrachera* is sometimes added to chicha, the nutritious daily beverage of low alcohol content (pers. comm.). However, she adds that many consider this an antisocial practice, since it often results in disorderly behavior and fighting.

A dozen cases of intentional intoxication with the other three important *Datura* cultivars have come to my attention.

As psychotropic drugs, it is 'Quinde', 'Munchira' and (reportedly) 'Culebra' which are employed principally. The juice of the leaves, or occasionally of the flowers, is taken, usually alone and unheated. Depending on the size of the leaves, between one leaf and twenty-four leaves ("twelve pairs") are taken. Normally the leaves are taken in pairs, and sometimes (Seijas, pers. comm.) only as even numbers of pairs. While one leaf is sufficient in the case of the large-leaved 'Salamán', two or four of the smaller 'Quinde' leaves are used. Between eight and twenty-four of the minute 'Munchira' leaves are required. The leaves are usually macerated and crushed and the expressed juices taken alone or sometimes mixed with a jigger of water or *trago* (alcoholic distillate), partly for convenience. Sugar is sometimes added to the juice to make it more palatable. One informant heated 'Munchira' leaves in a very small amount of water to extract the juices.

One medicine-man made the drug by expressing the juice from one flower each of 'Salamán', 'Quinde' and 'Munchira', thus obtaining about 15 cc. to which he added sugar. Another individual used only two flowers, both of 'Quinde'.

The psychotropic use of these *Daturas* is not restricted

PLATE LIII



Salvador Chindoy and his wife posing beside his aged 'Munchira' tree. (A prop prevents the crown from leaning on the roof of the house.)

to medicine-men; they are in exclusive possession of neither the trees nor of the knowledge of how to prepare the drug. However, it is likely that in many cases a medicine-man prepares or directs the preparation of the drug, especially with regard to dosage.

The descriptions of the psychotropic effects, related to me by those who have experienced them, are in remarkable agreement. It stuns them, makes them lose their senses, and leaves their mouths and throats so unpleasantly dry that they can neither swallow nor talk for many hours. Their vision is disturbed, bringing objects nearer and farther away, and some experience visual hallucinations, especially of animals that they fear. One woman said that taking 'Munchira' made her feel stronger and younger. Unfortunately, the dominant memory is of the long hours with a dry, constricted throat which prevented eating, drinking and speaking. Informants discussing *Datura* narcosis often continue on with their experiences with *biaxñ* (*Banisteriopsis* spp.), experiences that they usually recall as more pleasant and more valuable (6).

Chemistry

Chemical analyses of *Datura candida* 'Culebra' (*Methysticodendron Amesianum*) were done within five years after its description in 1955 by Schultes.

Theilkuhl found hyoscyamine and atropine in the leaves, though he believed the last-named was produced probably during the isolation process (35). Pachter and Hopkinson, who worked with thirteen kilograms of dried leaves and stems, found four alkaloids present, of which 1-scopolamine accounted for 80 per cent (25). Atropine was also present, but two others in smaller amount were not identified. The plant materials for both studies were obtained in the Valley of Sibundoy or originated from

such material. To my knowledge, no other *Datura* material deriving from populations in the Valley has been analyzed chemically or pharmacologically.

The alkaloids of the genus *Datura* have been subjected to intensive study. For a concise review by Edward Leete see Avery *et al.* (1). The principal alkaloids of the tree *Daturas* are the tropanes hyoscine (scopolamine), hyoscyamine and atropine. W. C. Evans and his co-workers are actively investigating these and closely related alkaloids in *Datura cornigera* (white flowered) and *D. sanguinea* (11, 12, 13, 14). Their efforts promise to demonstrate alkaloidal composition and biogenesis in all the tree *Daturas*. They are currently analyzing several of the cultivars described herein. The roots of tree *Daturas*, like those of the herbaceous forms, contain in addition to the above named alkaloids, esters of tiglic acid with 3 α -hydroxy-, 3 α , 6 β -dihydroxy- and 3 α , 6 β , 7 β -trihydroxytropene. Ditigloyl esters appear to be present in all the *Datura* species examined. *D. sanguinea* contains acetoxy derivatives, one occurring as the mixed ester 3 α -tigloyl-6 β -acetoxytropene.

Pharmacology

The psychotropic effects of the crude drugs upon the Sibundoy have been noted above.

Atropine, hyoscyamine and scopolamine are of considerable importance in modern medical practice, but the commercial sources of the drugs at present are other solanaceous genera, *Duboisia* and *Hyoscyamus*.

Henry summarizes the pharmacologic effects of these as follows (17):

When administered internally in toxic doses, atropine at first stimulates but eventually depresses the central nervous system, giving rise to hallucinations, incoherent speech, delirium and convulsions, followed by stupor and coma. It paralyzes muscles and secretory glands to the effects of stimulation by post ganglionic, cholinergic,

nerve fibres. It is to this action that the dryness of throat and mouth characteristic of belladonna poisoning is due.

The natural alkaloid, *l*-hyoscyamine and its *d*-isomeride resemble atropine (*d**l*-hyoscyamine) qualitatively in action. . . .

[Hyoscine (scopolamine)] has an action similar to, but more transitory than, that of atropine on the peripheral, cholergic, autonomic nervous system. Its action on the central nervous system is different. Generally it induces a feeling of fatigue and drowsiness passing into sleep. In some cases there may be a preliminary stage of excitement, and with large doses excitement indistinguishable from that of atropine intoxication may occur. The respiratory centre is depressed from the start. The *l*-isomeride has the more powerful peripheral action, although the central action of both isomerides is the same (p. 106-7).

Claus and Tyler (10) add that atropine applied locally causes a "dullness or slight paralysis of the sensory nerves", thus easing pain. This action probably relates to the frequent use of leaves in treating rheumatism.

General statements such as these give a good indication of the types of pharmacologic activity which probably will be demonstrated in the tree *Daturas*, and suggest the basis for both their medicinal and psychotropic use by the Sibundoy. However, because the Sibundoy *Daturas* are constant hosts to several viruses which may affect the cultivars differently, and because the Sibundoy have encountered greatly differing levels of toxicity, it seems very probable that an eventual understanding both of the biogenesis and of the pharmacologic activity of the Sibundoy *Datura* alkaloids will constitute a unique chapter in our increasing knowledge of the solanaceous tropane alkaloids.

Key to Datura in the Valley of Sibundoy

- A. Exposed corolla mostly red, leaves soft-pubescent *D. sanguinea*
 - a. Corolla tube yellow at the middle cv. Guamuco
 - aa. Corolla tube green or red at the middle, lacking yellow entirely cv. Sangre
- AA. Corolla lacking red, leaves not soft-pubescent . . . *D. candida*

Key to Datura (cont.)

- a. Corolla yellow-orange cv. Ocre
- aa. Corolla white
 - b. Corolla very deeply lobed, filaments apically contorted, leaves long-linear cv. Culebra
 - bb. Corolla slightly lobed, filaments straight, leaves not long-linear
 - c. Leaves with regular venation and uniform margins
 - d. Leaves dentate cv. Dientes
 - dd. Leaves entire
 - Pistil exceeding 30 cm., corolla 31–43 cm. cv. Andrés
 - Pistil less than 25 cm., corolla 20–30 cm.
 - Leaves yellowish, pistil 22–24 cm. cv. Biangán
 - Leaves not yellowish, pistil 14–21 cm. cv. Buyés
 - cc. Leaves with irregular venation and variously erose margins (cf. Plate LII) cvs. Amarón
Salamán
Quinde
Munchira

Taxonomy of the genus *Datura*
in the Valley of Sibundoy

1. *Datura sanguinea* Ruiz & Pavón Fl. Peruv. 2: 15. 1799.

Brugmansia bicolor Persoon Syn. Pl. 1: 216. 1805; Lindley Bot. Reg. 20: pl. 1739. 1834.

B. sanguinea D. Don in Sweet Brit. Fl. Gard. II. 3: pl. 272. 1835; Lagerheim Bot. Jahrb. Engl. 20: 662. 1895.

Small trees, 2–5 meters in height; leaves soft-pubescent, the lower repand to angular, the upper usually entire; flowers 17–25 cm. long, the corolla with a short-toothed, recurved to strongly reflexed (rarely erect) limb, the tube typically green within the calyx, yellow at the middle and red or orange-red (rarely yellow-orange to bronze) toward the limb, the ribs yellow; anthers 12–18 mm.; stigma obtuse; fruit ovoid (rarely oblong-elliptic), the base rounded to acute (rarely acuminate) and mucronate, in cross section usually bi-

Datura sanguinea

R. & P.

cv. GUAMUCO



Datura sanguinea R. & P. cv. Guamuco. Flowering and fruiting branches, $\times \frac{1}{2}$.

laterally flattened, or 4 5-sided to nearly round with 2 or 4 longitudinal sulci; seeds verruculose and lacking a greatly thickened testa.

1a. **'Guamuco'** n. cv. Plate LIV.

Calyx broad, 1-3-lobed, 6.7-12.2 cm. long; corolla 17.6-21.2 cm., yellow at the middle, red toward the limb; stamens 15.7-19.2 cm. (including their adnation to corolla), anthers 15-18 mm.; pistil 15.5-19 cm.; fruit ovoid to conical, bisulcate, with half-persistent calyx, rare. $N=12$ (*Bristol 1114*).

The pollen very closely resembles that of *D. candida*. Examination of 500 microspores of one plant showed 58.8 per cent to be abnormal.

Common names: *Guamuco*, *Guamucu borrachera*.

Guamuco is a non-Kamsá term, also used occasionally for *Spigelia pedunculata* HBK. It may relate to *guambia* 'poison', for the Sibundoy know both plants to be highly poisonous.

COLOMBIA: Comisaria del Putumayo: Valle de Sibundoy, alt. ca. 2200 m.—1.5 km. S Sibundoy. "Tree 3 m.; corolla yellow below, reddish orange above, veins yellow above; anthers white. In cultivation; very rare." 20-XII-1962, 419* (ECON).—San Andrés. "'Guamuco'. Shrub 2.5 m.; corolla orange-red, limb recurved. Cultivated, infreq." 18-III-1963, 653. (COL, ECON, PASTO, US).—3-5 kms. S Sibundoy. "'Guamuca borrachera'. Tree 3.5 m.; a few lvs. entire; corolla tube green, becoming yellow; throat and limb red, becoming orange during anthesis; anthers white, pollen abundant; no fruit. Indian garden, very infreq." 12-VI-1963, 1114 (COL, ECON, BISH, PASTO, S, US).—2 kms. SE Sibundoy. "'Guamuco'. Shrub 2 m.; corolla tube green, becoming light orange, limb and throat deep red, becoming lighter. Indian houseyard, very infreq." 27-VIII-1963, 1345 (COL).—Colón. "'Guamuca borrachera'. Tree 4 m., trunk diam. 23 cm., young bark brown; calyx slightly purplish; corolla red-orange except greenish yellow where emerging from calyx, and the ribs yellow, limb recurved; fr. ovoid or triangular, acuminate with 2 furrows, the calyx half-persistent; seeds dark brown." 23-IX-1963, 1420 (COL, ECON, BISH, K, PASTO, US).—Sibundoy. 29-V-1946, *Schultes & Villarreal 7689* (COL, ECON, US).

* Collection numbers are those of the author, unless otherwise specified.

1b. cv. **Sangre.**

This cultivar, described in Bot. Mus. Leaflet Harvard Univ. 21: 236 (1966), is distinguished by the corolla color, which is deep red (basally green), entirely lacking in yellow. The flower size and shape is variable: in the Valley of Sibundoy, the calyx is narrow, terminating in a single apicule, 8.8–9.5 cm. long, the corolla 17.6–21 cm. long. Stamens (incl. their adnation to corolla) 15.4–18.9 cm., anthers 13–14 mm. and pistil 16.9–19 cm. The oblong, bisulcate fruit has a persistent calyx.

Common names: *Guamuco*, *Guamuco borrachera*, as for the first cultivar.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—San Andrés. “‘Guamuco’. Shrub 2.5 m.; corolla red, limb spread somewhat, but not rolled upward as in 653. Cultivated.” 18-III-1963, 652 (COL, ECON, PASTO, US).—San Andrés. “Arborescent 2.5 m.; exposed corolla red (no yellow present); fr. 90×55 mm., ovoid, 5-ridged, not flattened. Roadside, common.” 20-VIII-1963, 1309 (COL, ECON, US).

2. **Datura candida** (*Pers.*) Safford in Journ. Wash. Acad. Sci. 11: 182. 1921.

D. arborea Ruiz & Pavón Fl. Peruv. 2: 15. pl. 128. 1799; non *D. arborea* L.

Brugmansia candida Persoon Syn. Pl. 1: 216. 1805.

D. aurea Lagerheim Gartenfl. 42: 33. 1893; Safford *ibid.* 186. 1921.

B. aurea Lagerheim in Bot. Jahrb. Engl. 20: 664. 1895.

B. arborea Lagerheim *ibid.* 663.

D. affinis Safford *ibid.* 186.

D. Pittieri Safford *ibid.* 187.

Small trees, 3–5 meters in height; leaves glabrous or slightly pubescent, ovate or oblong-elliptic, entire or coarsely dentate; calyx 1.5–3 cm. broad, 1–4-toothed; the slender basal part of the white corolla wholly enclosed by the calyx, the limb flaring broadly with long

(4–9 cm.) recurved teeth: anthers distinct: fruit oblong-cylindric to fusiform and lacking a persistent calyx: seeds angular, with a greatly thickened, suberose testa.

2a. ‘**Buyés**’ n. cv. Plates XLIX and LV.

Ratio of leaf width to length .346–.577, calyx 8.5–16.1 cm., corolla 19.6–29.3 cm., stamens (incl. adnation of filaments to corolla) 13.2–19.9 cm., anthers 30–41 mm., pistil 14.3–21.2 cm. N=12 (*Bristol 1117, 1266*).

This is the common *borrachera* found throughout the Valley in inhabited locations and where there is evidence of sites of former habitation. Cv. Buyés is the most variable of all the *D. candida* cultivars. Several to many clones are included here, but they are only obscurely differentiated, and neither the natives nor the people of Spanish descent distinguish among them. Differences in the splitting of the calyx, diameter of corolla tube, length of corolla and length of corolla teeth, as well as others, can be seen.

Common names: *Borrachera*, *borracherushe*, *buyés* *borrachera*, *buyés* *borracherushe*, *borrachera de agua*, *floripundo*, *floripondio blanco*, *guamuco blanco*, *guamuco floripundo*.

Borrachera ‘inebriant’ is from the Spanish *borracha* ‘wine skin’, whence *borracho* ‘drunkard’. The Sibundoy believe it to be a word of their own language, Kamsá, an indication of its long usage among them. Elsewhere in Colombia *D. candida* is known as *borrachero* ‘inebriating tree’.

Borracherushe is a variant, and more typically Kamsá form, of the first.

Buyés ‘water’ is of unexplained application here, but perhaps it refers to the plant’s preference for a wet site, and the common habit of planting it near ditches.



Datura candida (Pers.) Saff. cv. Buyés. Flowering and fruiting branches, $\times \frac{1}{3}$.

Floripondio (Spanish) 'floribunda' refers to "the size and abundance of its flowers" (38).

Agua (Spanish) 'water', equivalent to *buyés*.

Blanco (Spanish) 'white', for the flower color.

Guamuco (language?) is the name in the Valley and elsewhere for the red-flowered *D. sanguinea*.

Buyés borrachera and its variants are employed with about equal frequency by the Sibundoy, while the remaining names are used only by immigrants from Nariño and elsewhere in Colombia.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—Sibundoy, collados al norte del pueblo. "Nombre castellano: 'borrachera'. Large bush. Fl. white." 12-II-1942, *Schultes* 3207 (GH, NY).—Sibundoy. "'Bui-ish borrachera'. Tree 4 m.; corolla white, fragrant, limb cordate between teeth. Calyx teeth 2–3. Borders, freq." 26-IV-1963, 887 (COL, ECON, BISH, K, PASTO, S, US).—Sibundoy. "'Bui-ish borrachera'. Arborescent 2.5 m.; corolla white. Borders, frequent." 26-IV-1963, 889 (ECON).—3 km. SW Sibundoy. "Tree 4 m.; corolla white. Infreq. in borders." 9-V-1963, 999 (COL, ECON, PASTO, US).—4 km. SW Sibundoy. "'Bui-ish borrachera'. Tree 4 m. Secondary woodland." 3-VI-1963, 1098 (COL, ECON, K, PASTO, US).—Sibundoy. "'Bui-ish borrachera'. Tree 3.5 m.; corolla white; frs. green, few. Hedge row, frequent." 10-VI-1963, 1109 (COL, ECON, US).—3–5 km. S Sibundoy. "'Bui-ish borrachera'. Tree 5 m.; corolla white; fr. green. Borders, common." 12-VI-1963, 1117 (COL, ECON, US).—Sibundoy. "'Bui-ish borrachera'. Tree 4 m.; frs. pendulous, corolla white; fr. green, indehiscent. Border, frequent." 10-VI-1963, 1193 (COL, ECON, BISH, K, PASTO, S, US).—Sibundoy. "'Bui-ish borrachera'. Tree 4 m.; corolla white, limb recurved. Borders, frequent." 22-VII-1963, 1255 (COL, ECON, BISH, K, PASTO, S, US).—Colón. "Tree 2.5 m.; corolla white. Border, Indian garden." 25-VII-1963, 1266 (COL, ECON, BISH, K, PASTO, S, US).—2 km. SW Sibundoy. "'Bui-ish borrachera'. Arborescent 2–5 m.; frs. pendulous, corolla emerging pale yellow, white when fully open; anthers white; stigma very pale yellow. Borders, common." 19-IX-1963, 1388 (ECON).

2b. 'Dientes' n. cv.

Leaves dentate, ratio of width to length .550, calyx

11.1–13.4 cm., corolla 22.5–25.7 cm., stamens (incl. adnation of filaments to corolla) 14.3–16.5 cm., anthers 32–38 mm., pistil 15.8–17.8 cm., fruiting occasionally.

The distinguishing feature of this cultivar is the dentate leaf margin which is usually restricted to the distal half of the leaf, but which may occur throughout the length. Almost all of the plants in the Valley of Sibundoy occur in a single locality two to three kilometers southeast of the town of Sibundoy. Along three main trails covering two kilometers here, the many landowners have planted nearly 250 of these trees.

Common names: *Buyés borrachera*, etc., the same as for *D. candida* 'Buyés'.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—2 km. SW Sibundoy. "Trailside, very infreq." 14-IV-1963, 774 (ECON).—3 km. S Sibundoy. "'Bui-ish borrachera'. Tree 4 m.; corolla white; fr. green, pericarp drying and decaying but indehiscent. Border, infreq." 15-VI-1963, 1122 (ECON).—2.5 km. S Sibundoy. "'Bui-ish borrachera'. Tree 4 m.; corolla white, pendulous; frs. broadly fusiform, indehiscent. Borders." 2-X-1963, 1435 (COL, ECON).—2.5 km. S Sibundoy. "Arborescent 3 m.; corolla white, pendulous. Indian gardens, borders; frequent." 2-X-1963, 1438 (ECON).—2 km. SE Sibundoy. "Arborescent 4 m.; corolla pendulous, white, limb and teeth recurved; fr. terete, fusiform (15.5 × 3.5 cm.), indehiscent. Borders, frequent." 8-X-1963, 1447 (COL, ECON, BISH, K, PASTO, S, US).

Another collection (1111) has both distally dentate and entire leaves from the same plant. In addition, the calyx is very narrow with the limb partly recurved, and the corolla tube is also narrow. Ten to 12 trees occur in a single hedge row in the town of Sibundoy. During May and early June, 1963, the only *Daturas* blooming in the Valley were this planting and 'Culebra'. The owner called this "'bui-ish borracherushe'" and said that the first cuttings had been brought here from further south in the Valley, where most of the Sibundoy reside.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—Sibundoy. “‘Bui-ish borracherushe’. Tree 3.5 m.; lvs. entire or distally toothed; calyx slender, limb curling; corolla white. Hedge row, infreq.” 11-VI-1963, 1111 (COL, ECON, BISH, K, PASTO, S, US).

2c. ‘Ocre’ n. cv. Plate LVII.

Leaves entire, the base acute, ratio of width to length .402–.498, calyx relatively narrow, 12.8–15.9 cm., corolla long, 25.4–31 cm., ochre color, stamens (including their adnation to corolla) 16.4–22.6 cm., anthers very long, 40–44 mm., pistil 17.8–23.8 cm. Fruit not seen. N=12 (*Bristol 1267*).

This very rare cultivar is unique in the light orange or ochraceous color of its flowers. Two plantings are known, a single tree near Sibundoy, and a short hedge row in Colón. The present owners of these trees with strikingly different flowers showed little interest in them.

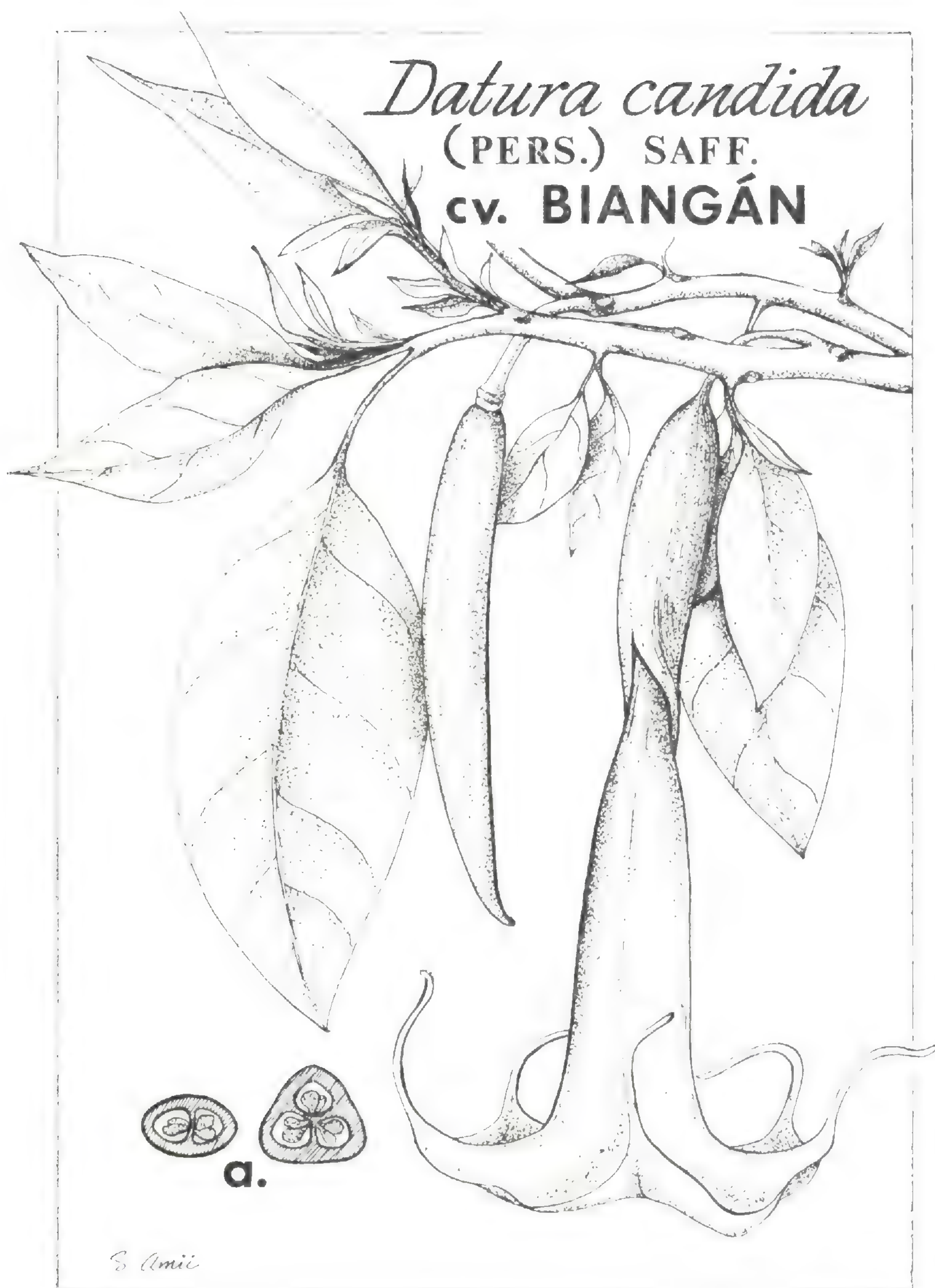
Common names: The only name given this cultivar by its owners is *borrachera* (‘inebriant’) in Sibundoy and *borrachero* (‘inebriant tree’) in Colón. In Sibundoy, the response *tsushie borrachera* (‘yellow inebriant’) was eventually evoked, but it was clear that *tsushie* was a purely descriptive word and not an established phytonym.

COLOMBIA: Comisaria del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—Colón. “‘Borrachero’. Tree 4.5 m.; corolla light orange; not fruiting. Indian garden, very infreq.” 25-VII-1963, 1267 (COL, ECON, BISH, K, PASTO, S, US).—1.5 km. SW Sibundoy. “‘Tsa-shie borrachera’. Tree 3 m.; corolla light orange. Indian garden, very infreq.” 12-VIII-1963, 1297 (COL, ECON, PASTO, US).

2d. ‘Biangán’ n. cv. Plate LVI.

Leaves yellowish, entire, ratio of width to length, .318–.488, calyx length 10.2–16.3 cm., corolla long, 28–32.9 cm., in some the slender basal part of the tube well exposed, stamens (including their adnation to corolla) 19.9–23.2 cm., anthers 37–43 mm., pistil 21.6–24.4

Datura candida
(PERS.) SAFF.
cv. BIANGÁN



Datura candida (Pers.) Saff. cv. Biangán. Flowering and fruiting branches, $\times \frac{1}{3}$. a, Cross sections of two fruits from the same tree, $\times \frac{1}{2}$.

cm., fruit occasional, narrowly fusiform, somewhat grooved and ridged, 2 or 3 locular, calyx persistent or caducous. N = 12 (*Bristol 1431*).

Cv. *Biangán* is easily recognized by the yellowish foliage and, if they are available, the unusual fruits, resembling those described by Safford (28) for *D. suaveolens*. A photograph of '*Biangán*' flowers appears in Perry (27), page 335, centre figure.

Common names: *Biangán borrachera*, *chontaruco borrachera*, *danta borrachera*.

The Sibundoy know two deer, a small one (*biangán*), said to be only one half meter high, which lives near the marsh in the centre of the Valley, and a larger one (*mongojo*) of the high mountains and páramos. *Chontaruco* ('*biangán*') may be an Inga term, while *danta* ('tapir') is a widespread indigenous word adopted by Spanish. The Sibundoy think of *D. candida* '*Biangán*' as a stimulant for dogs on hunting trips, but whether their names refer to inebriated dogs capturing game animals or to the possibility of game animals becoming inebriated themselves by browsing on the leaves, is unclear to me.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. ca. 2200 m.—Sibundoy. "'Danta borrachera'. Bush''. 29-V-1946, *Schultes & Villarreal 7638*(US).—Sibundoy. "N.v. 'Danta borrachero,' 'Biangán borrachero' (Kamsa). Arbusto de 3 m. Hojas amarillentas. Flores vivas, no vistas. (Se toma como estimulante cuando se siente cansancio y tambien como alucinógeno)." 12-VI-1956, *Idrobo 2231* (COL).—3 km. SE Sibundoy. "'Bui-ish borrachera'. Arborescent 3 m.; upper lvs. small, yellowish; flrs. (except calyx) white throughout. Edge of cornfield." 8-I-1963, *458* (COL, ECON, PASTO).—5 km. SW Sibundoy. "'Biangán borrachera'. Arborescent 2.5 m., lvs. yellowish green, calyx becoming yellow; corolla white (between lobes rounded or very slightly emarginate); no fr." 29-IV-1963, *890* (COL, ECON, BISH, K, PASTO, S, US).—5 km. S Sibundoy. "'Biangán borrachera'. Tree 3.5 m., lvs. yellowish; corolla white; fr. green (loose, persistent calyx removed), 2-3 carpellate. Border, very infrequent." 27-VI-1963, *1162* (COL, ECON, K, PASTO, US).—3 km. S Sibundoy. "'Biangán borrachera'. 2 m., lvs. yellow-green; corolla white; frs. green, 2-3 carpellate, angular and grooved

(2 carpellate flattened). 18-VII-1963, 1246 (COL, ECON, US).—2 km. SE Sibundoy. “‘Biangan borrachera’. Shrub 2 m.; leaves and calyces yellowish; corolla white. Pasture border, infreq.” 27-VIII-1963, 1348 (ECON).—1.5 km. S Sibundoy. “‘Biangan borrachera’. Tree 3.5 m.; lvs. yellowish; corolla white. Indian garden, very infreq.” 30-VIII-1963, 1356 (ECON).—1.5 km. S Sibundoy. “‘Biangan borrachera’. Tree 3 m., lvs. yellowish; flrs. pendulous, corolla white, limb recurved but teeth hanging downward, limb from base of tooth to segment edge rolled backward. Indian houseyard, very infreq.” 2-X-1963, 1431 (COL, ECON, BISH, K, PASTO, US).

2e. ‘**Amarón**’ n. cv. Plate LVII.

Leaves deformed, lanceolate to oblong, reaching 45 cm., margin irregularly undulate and obscurely dentate, or not vertically undulate and strongly dentate, the lateral veins curving near midrib, often forming a slight S-curve; ratio of width to length .213–.364; calyx 9.4–15.5 cm., corolla 20.3–27.8 cm., the tube relatively broad, stamens 13–18.2 cm. (including their adnation to corolla), anthers short, 28–34 mm., pistil 14–19.8 cm., fruit occasional. N=12 (*Bristol 564*).

Cv. Amarón, consisting of several clones, occurs at many localities in the Valley, sometimes in extensive hedge plantings. Probably there are in excess of 200 trees. The variable leaves may be lanceolate to narrowly oblong and with the margins both horizontally and vertically undulate and sometimes distally dentate. A few plants have both irregular leaves and leaves similar to ‘Buyés’ leaves in outline, but with the venation distorted. Most of the plants grow a little more vigorously than the other cultivars, as seen in the greater size of the trees, the leaves and fruits and in the thickness of young stems.

Common names: *Amarón borrachera*, *cucu borrachera*.

Amarrón (Spanish) ‘boa constrictor’, a thick, heavy-bodied snake. Possibly the name is applied to this cultivar in recognition of the very thick, young herbaceous

PLATE LVII



Datura candida (Pers.) Saff. (Upper) Foliage of cv. Amarón. (Lower) Emergent and open flowers of cv. Ocre.

stems which usually distinguish this from all the other cultivars.

Cucu was given by only one informant. The basic meaning of the word among the Sibundoy is not known to me. Spanish speakers use it in reference to 'devil' (Seijas, pers. comm.). Pazos (26), considering Quechua vocabulary in use in Colombia today, gives "Quechua, *kuku*: espantajo, fantasma", apparently 'fright, ghost'. However, Lira (23), in his exhaustive treatment of Quechua in the Inca heartland in southern Peru, gives the following: "K'UKU, adj. Inmaduro, no maduro, verde y duro, fruto verdete sin sazón. *I'am*. Divieso o quiste endurecido." The familiar application *divieso* 'furuncle, boil' and *quiste* 'cyst' is the most likely sense of the term here, for this cultivar (as well as others) has been used as a suppurant in treating boils and cysts.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2900–3180 m.—Road from Sibundoy to Pasto: between La María and Páramo de San Antonio. "Bush 12 ft. Fl. white." 1-VI-1946, *Schultes & Villarreal* 7809 (ECON, US). Valle de Sibundoy, alt. 2200 m.—3 km. S Sibundoy. "'Amarrón borrachera'. Tree 3 m.; corolla yellow upon emergence, white expanded. Cultigen; prop. vegetatively; infrequent." 27-II-1963, 564 (COL, ECON, BISH, K, PASTO, S, US).—3 km. S Sibundoy. "Tree 6 m.; corolla emerging yellow, white expanded. Cultigen; prop. vegetatively: infrequent." 27-II-1963, 565 (COL, ECON, BISH, K, PASTO, S, US).—3 km. S Sibundoy. "Tree 3 m.; corolla emerging yellow, white expanded. Cultigen; prop. vegetatively; infrequent." 27-II-1963, 567 (COL, ECON, BISH, K, PASTO, S, US).—2 km. SW Sibundoy. "Tree 3.5 m.; corolla white. Indian garden, infreq." 14-IV-1963, 775 (ECON).—3 km. S Sibundoy. "'Amarrón borrachera'. Tree 4.5 m.; corolla white; frs. green, few. Indian garden, infreq." 10-VI-1963, 1110 (ECON).—3 km. S Sibundoy. "'Amarrón borrachera'. Tree 4 m.; corolla white; frs. green, few. Indian garden, very infreq." 2-VII-1963, 1189 (COL, ECON, US).—4 km. S Sibundoy. "'Amarrón borrachera'. Tree 2.5 m.; corolla white; fr. green. Indian garden, very infreq." 7-VII-1963, 1192 (COL, ECON, US).—Colón. "'Borrachero'. Tree 3.5 m.; corolla white, pendulous; fr. green. Border, infreq." 16-VII-1963, 1213 (COL, ECON, BISH, K, PASTO, S, US).—2 km. S Sibundoy. "'Amarrón borrachera'. Tree 3.5 m.;

corolla white. Border, infreq.” 15-VIII-1963, 1305 (COL, ECON, BISH, K, PASTO, S, US).—2 km. SE Sibundoy. “‘Cucu borrachera’. Tree 4 m.; corolla white. Indian houseyard, infreq.” 27-VIII-1963, 1346 (ECON).

2f. ‘**Salamán**’ n. cv.

Leaves long, the margins strongly undulate vertically, the distal half greatly deformed and little developed; calyx 9.9–15.1 cm., corolla 23.3–27 cm., stamens 14.8–16.9 cm. (including their adnation to corolla), anthers relatively very short, 25–28 mm., pistil 15.7–18 cm.; not known to fruit.

Cv. Salamán is perhaps the rarest of the *Datura* cultivars in the Valley. One Sibundoy owns three trees derived from a single cutting that he planted years ago: it was brought to him from just outside the Valley, where the rivers exit through a cleft in the mountains. That area is very sparsely settled today, and most of its inhabitants are not Indians. A cursory inspection of the area failed to locate any tree *Datura*.

Common names: *Salvanje borrachera* (Kamsá), *salamanga borrachera* (Inga), *salamán borrachera* (Spanish).

Salamán and its variants are employed by the same person, the owner of the plants, in the three languages which he speaks.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2200 m.—Sibundoy. “N. v. ‘Salamán-borrachero’, ‘Salvaje-borrachera’. Arbol de 4 m. Botones erectos u horizontales. Corolas blancas, aromáticas. Los indios la distinguen como especie, pero parece ser un estado intermedio entre el 2207 [not seen] y 2223 [cv. Munchira].” 12-VI-1956, *Idrobo* 2224 (COL).—1.5 km. S Sibundoy. “‘Salamán borrachera’. Narcotic. Tree 5 m.; corolla white, pendulous; not fruiting. A few leaves on young, vigorous shoots are undeformed.” 11-VI-1963, 1194 (COL, ECON, BISH, K, PASTO, S, US).—1.5 km. S Sibundoy. “‘Salamán borrachera’. Tree 5 m.; corolla white, pendulous; not fruiting. Indian garden, very infreq.” 2-X-1963, 1432 (ECON).

The oldest of the three trees seen is five meters high,

about the limit for a tree *Datura*, and many of its branches have small leaves which are only two or three times longer than the diminutive leaves of 'Munchira', which are characteristically the same shape. Observing the same trees, J.M. Idrobo had already noted the resemblance to 'Munchira' (*Idrobo 2224*).

Two unusual flowers (*Bristol 1448*) were discovered on one branch of a 'Salamán' tree. They may be interpreted as chimera in origin. They demonstrate the possibility of obtaining striking new cultivars from existing ones by vegetative propagation of such anomalous branches. The flowers are small, with all parts much shorter than normal 'Salamán' flowers, the corollas being only 21.8 and 22.5 cm. long. Most striking is the failure of the corolla limb to complete its growth and recurve. Instead, the limb flares only slightly and its margin between the teeth, rather than being rounded outward or cordate, is concave. The pistil falls far short of the stamens which in all other tree *Daturas* it exceeds.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy.—1.5 km. S Sibundoy. "'Salamán borrachera'. Tree 4 m.; aberrant branch with 2 small flrs., corolla white, limb flaring only 45 degrees, its edges crinkled. Indian garden, very infreq.'" 8-X-1963, 1448 (ECON).

2g. 'Quinde' n. cv. Plate LVIII.

Leaves very irregular, frequently with two lateral veins and their associated laminar tissue in the basal half well developed, and the distal half with relatively less development; the flowers often somewhat smaller than in the other clones, calyx 10.3–15.6 cm., corolla 19.7–25.2 cm., stamens 13.2–15.9 cm. (including their adnation to corolla), anthers relatively short, 26–33 mm., pistil 13.1–18.1 cm.; fruit occasional, the calyx sometimes persistent. N=12 (*Bristol 327, 1304, 1433*).

Common names: *Ngunsiana borrachera*, *quinde borrachera*, *cari borrachero*.

Ngunsiana (Kamsá) 'hummingbird', according to a Sibundoy, from the common long-tailed hummingbird of the Valley, the tail and wings of which are represented by the leaf of this cultivar.

Quinde (Inga) 'hummingbird'.

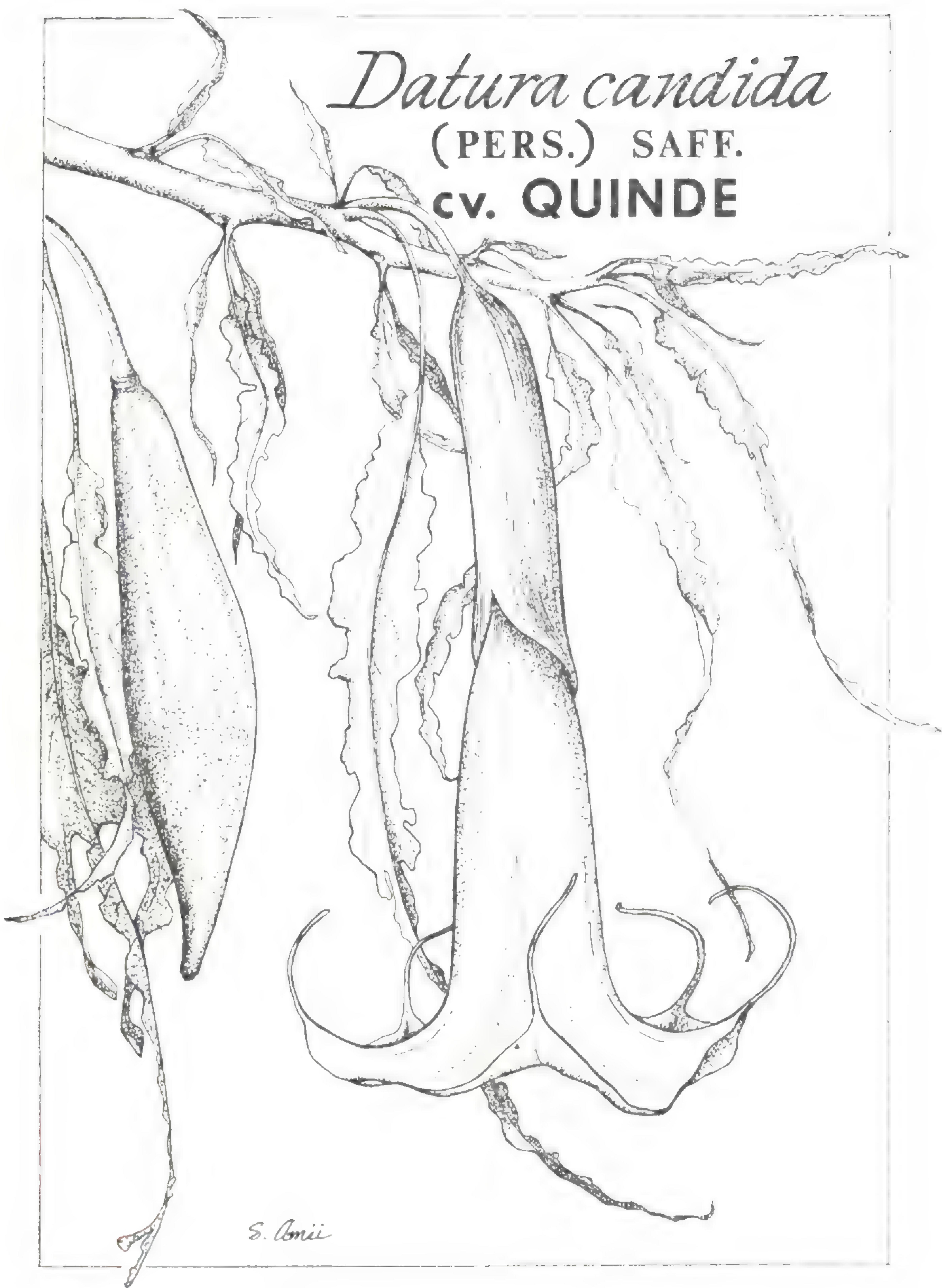
Cari (Inga!), apparently from KKHARI (Quechua) 'male' and familiarly, 'valiant, aggressive, energetic person' (23), suggesting one reason for the psychotropic use of this cultivar.

Chalua borrachero, once recorded, should perhaps be discounted, since the Quechua term CH'ALLU 'ripe' (23) may have been used by an Inga-speaking informant simply to indicate a stage of development, perhaps of the fruit.

Quinde and *quinde borrachera* are nearly universal terms for this cultivar.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2200 m.—Sibundoy. "'Borrachero' ". 25-V-1935, *García-Barriga* 4640 (ECON, US).—3 km. S Sibundoy. "'Quinde borrachera'. Tree 3 m.; corolla emerging yellow, white expanded; bearing mature fruit. Cultigen; prop. vegetatively; infrequent." 27-II-1963, 566 (COL, ECON, BISH, K, PASTO, US).—4 km. SE Sibundoy. "'Quinde borrachera'. Tree 4 m.; corolla white; frs. green. Border; very infreq." 15-VI-1963, 1121 (COL, ECON, K, PASTO, S, US).—1.5 km. SW Sibundoy. "Shrub 2 m.; corolla white. Indian garden, very infreq." 12-VIII-1963, 1299 (COL, ECON, BISH, K, PASTO, S, US).—1.5 km. S Sibundoy. "'Quinde borrachera'. Tree 2.5 m.; corolla white. Indian garden, very infreq." 15-VIII-1963, 1304 (ECON).—1.5 km. W Sibundoy. "'Quinde borrachera'. Arborescent 3.5 m.; corolla white; fr. terete, green. Indian garden, very infreq." 22-VIII-1963, 1333 (ECON).—2.5 km. S Sibundoy. "'Quinde borrachera'. Shrub 2.5 m.; corolla white, pendulous; fruit green. Indian garden, very infreq." 2-X-1963, 1434 (ECON).—2.5 km. S Sibundoy. "'Quinde borrachera'. Arborescent 4 m.; corolla white, pendulous; fr. fusiform, indehiscent. Indian garden, very infreq." 2-X-1963, 1439 (ECON). Valle de Sibundoy, alt. 2500–2600 m.—2 km. NW Sibundoy. "'Quinde borrachera'. Arborescent 3.5 m.; corolla white. Secondary growth, far from any sign of dwelling. Solitary plant." 29-V-1963, 1080 (COL, ECON). 3 km. N San Pedro. "'Munchira'. Arbusto 2.5 m.; flor blanca." 9-VIII-1963, *Juajibioy Chindoy* 190 (COL, ECON, US).

Datura candida
(PERS.) SAFF.
cv. QUINDE



Datura candida (Pers.) Saff. cv. Quinde. Flowering and fruiting branches, $\times \frac{1}{2}$.

Hernando García-Barriga collected the earliest specimen that I have seen, and I credit him as the discoverer, in 1935, of the peculiar tree *Datura* cultivars of the Sibundoy.

2h. '**Munchira**' n. cv. Plates LIII, LIX.

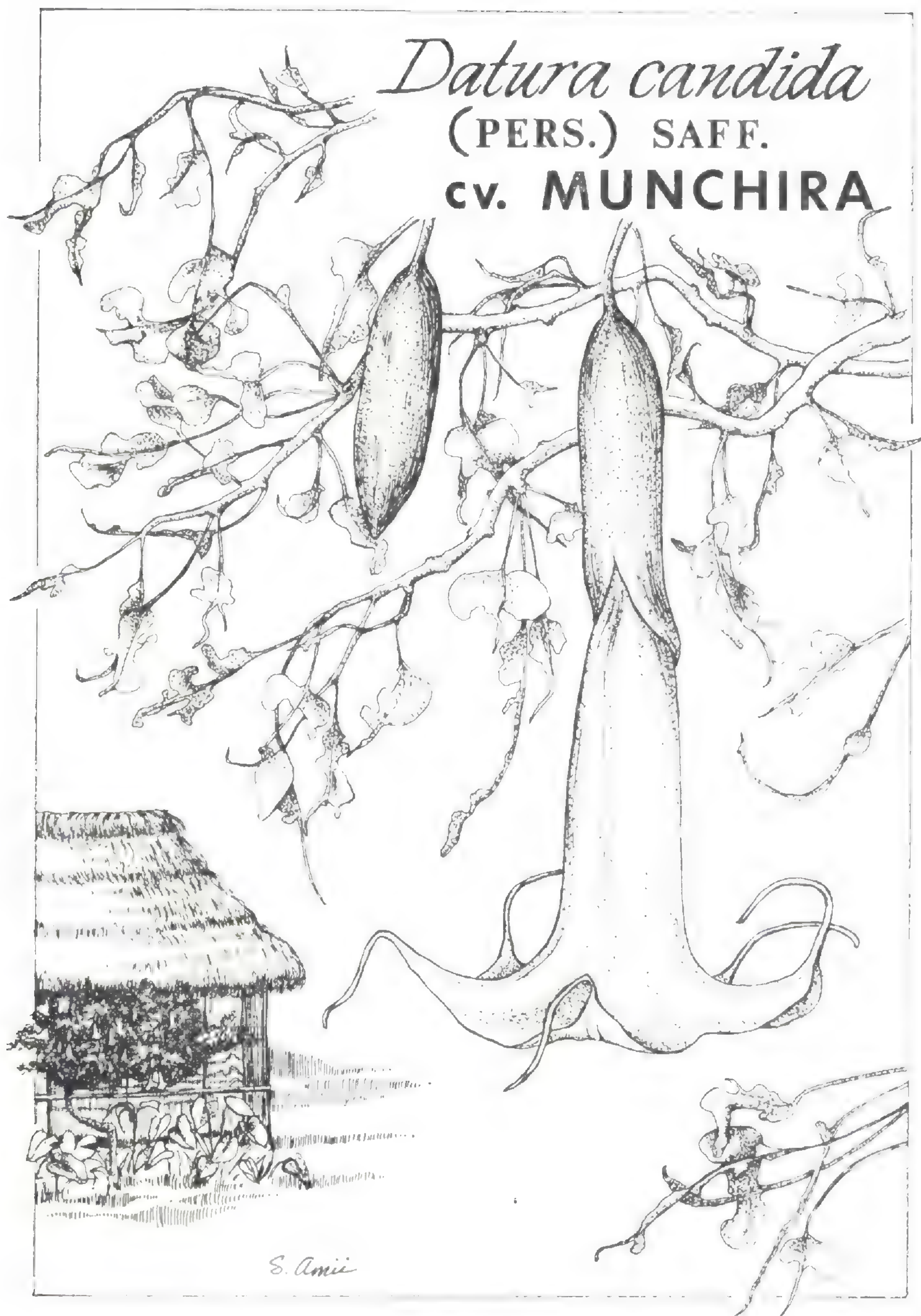
Appearing stunted, usually 1.5–2 m. high, but reaching 3 m. with age, the branches short and twisted, with scarcely elongated internodes, leaves relatively minute, variously much deformed, especially distally, calyx short, 9.3–12 cm., corolla 21.2–29 cm., stamens 15–16.7 cm. (including their adnation to corolla), anthers short, 27–30 mm., pistil 14.2–21.3 mm.; not known to fruit. N=12 (*Bristol 1268*).

These striking, stunted plants are among the rarer, for there may be no more than 15 in existence. If one of these treelets be pollarded or cut back to the ground, one or more vigorous shoots arise, as with all the cultivars, and there is no sign of stunting for several months. Perry (27) illustrated a flowering branch of this cultivar being examined by Salvador Chindoy and me (p. 335, top figure).

Common names: *Munchira borrachera*.

Munchira (Inga) 'caterpillar' alludes to the appearance of the leaves which seem to be (but definitely are not) *munchiradas* 'caterpillar eaten'.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2200 m.—Sibundoy. "N. v. 'Munchira'. Sufrutex y arbusto hasta de 2 m.; con ramas muy tortuosas; tronco principal y ramas primarias cubiertas de musgo. La atrofia en las hojas se dice que prevalece en todos los clones. Muy conocido para tomar como estupefaciente; vermífugo. Se dice que el principio es muy activo. Botones florales horizontales y pendulos." 12-VI-1956, *Idrobo 2223* (COL).—1.5 km. S Sibundoy. "'Munchira borrachera'. Narcotic. Tree 3 m.; corolla white; never fruiting. Indian dooryard, very infreq." 26-VII-1963, *1268* (COL, ECON, BISH, K, PASTO, S, US).—San Andrés. "Arborescent 1.8 m.; corolla white. Indian garden, very infreq." 20-VIII-1963, *1311* (ECON).



Datura candida (Pers.) Saff. cv. Munchira. Flowering branch, $\frac{1}{3}$, and habit.

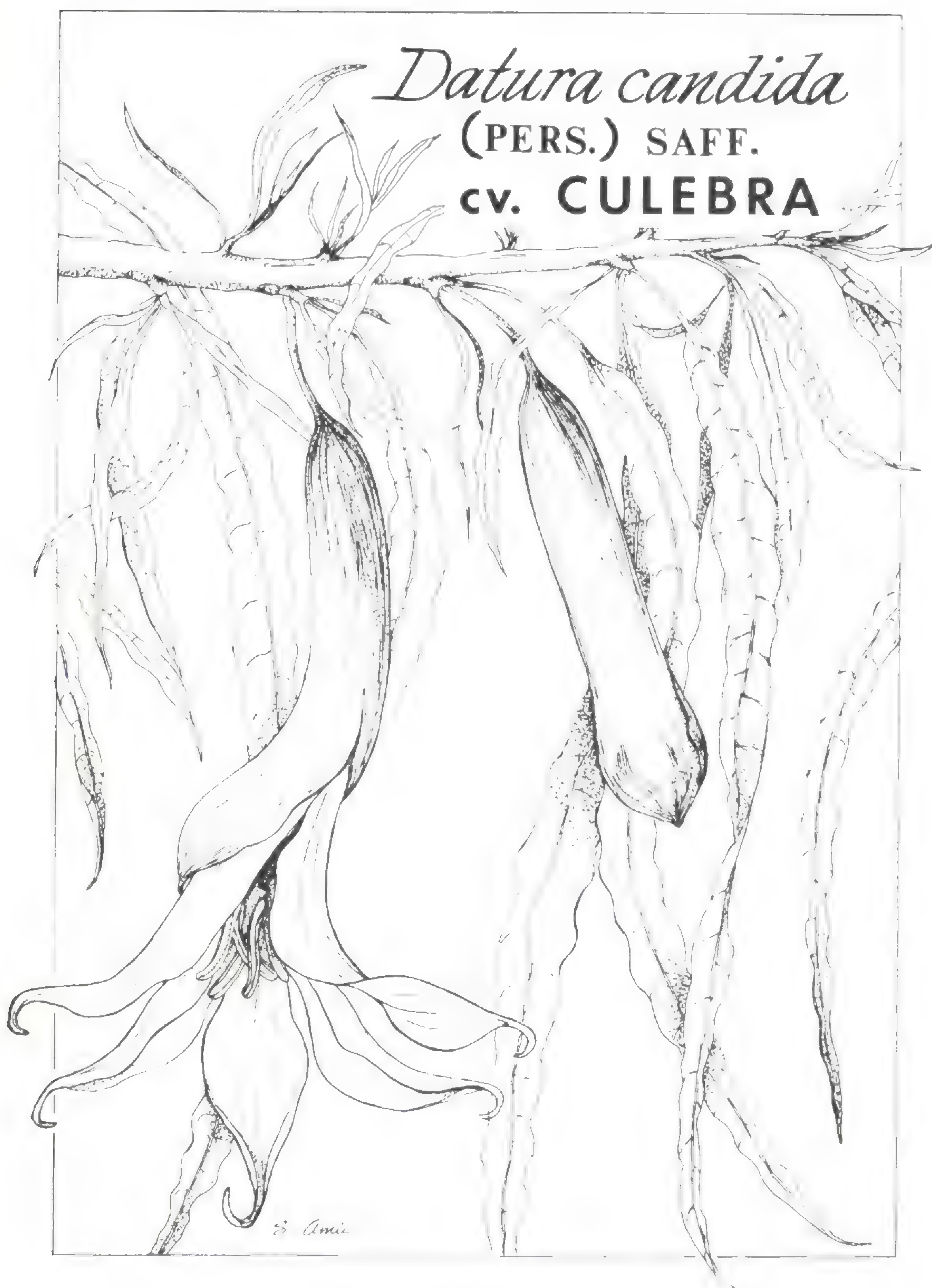
2i. 'Culebra' n. cv. Plates LX, LXI.

Methysticodendron Amesianum R. E. Schultes Bot. Mus. Leaflet. Harvard Univ. 17: 2. 1955.

Leaves narrowly linear-ligulate, ratio of width to length .036-.092, margin undulate; calyx distally inflated, 10.3-15.8 cm.; corolla shortest among the cultivars, 15.1-24.5 cm. (excluding the relatively short teeth), deeply divided (through $\frac{3}{4}$ of total length) into long spatulate lobes; stamens 12-16 cm. (including their adnation to corolla), the filaments distally and irregularly contorted, anthers 25-32 mm.; pistil shortest among the cultivars, 9-12.1 cm., with a variable number (2-4) of incompletely coherent styles exceeded by the stamens, the ovary often three-locular and with one or more variably developed appendages homologous with the styles. Fruiting rarely or never. $N = 12$ (3, 7). (For an exhaustive and illustrated description, including details of pollen morphology, see Schultes 1955.)

While strikingly different from all other *Datura* cultivars in the Valley of Sibundoy, there is little justification for excluding cv. Culebra from the genus *Datura* (3, 5, 7, 35, 37). Aberrant forms bearing a resemblance to this one have been observed in *D. Stramonium*, and also in a single, but very distinct, tree *Datura* collection from elsewhere in Colombia (7).

The origin of 'Culebra' is unknown, but it may safely be assumed to derive from one of the white flowered tree *Daturas*, and it is tentatively placed with *D. candida*. With the exception of *Datura* 'Andrés', a putative hybrid between *D. candida* and *D. suaveolens* Humb. & Bonpl. ex Willd., all of the other white flowered cultivars in the Valley belong with *D. candida*. As with these cultivars, 'Culebra' is known only from the Valley of Sibundoy, and hence it can be considered a member of the same *D. candida* complex for the present.



Datura candida (Pers.) Saff. cv. Culebra. Flowering branch, $\times \frac{1}{2}$.

Studying material grown at Bogotá, Theilkuhl found 62.7 per cent of the flowers to be bilocular, the remainder being trilocular, a rare condition in the Solanaceae. With regard to the possible failure to form fruit, it is interesting to note that, in Bogotá, the styles "usually begin to wilt before the opening of the anthers", thus eliminating the possibility of self fertilization (35).

Schultes recalled his lost collections of fruit as fusiform and about six inches in length, "very like the fruit of *D. suaveolens*" (29). This description, and the observations of both 2- and 3-locular ovaries suggest the fruits of *D. candida* 'Biangán'.

The possibility of a hybrid origin cannot be eliminated, but it is clear that 'Culebra' is not morphologically intermediate between *D. candida* and either *D. suaveolens* or *D. sanguinea*.

Common names: *Mutseuai borrachera*, *culebra borrachera*.

Mutseuai (Kamsá) and *culebra* (Spanish) mean 'snake', in reference to the long slender leaves.

Reports (29) of other names applicable to this cultivar arise either from uninformed natives (to many, the trees are little known though a subject of curiosity), or from misunderstandings in widely ranging conversation (informed individuals may discuss much more than the information solicited, perhaps without the interrogator's awareness).

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2200 m. — Los alrededores de Sibundoy. "Nombre kamsá: kinde-borrachera. Nombre castellano: culebra borrachera. Used in Sibundoy by Kamsá Indians as a divinatory narcotic and poison." 16-II-1942, Schultes 3256 (COL, ECON, US). Cotype *Methysticodendron Amesianum* R.E. Schultes.) — Sibundoy. "'Culebra borrachero'. In garden near house of an Indian herb doctor. Erect shrub 3-4 m. tall, fls. white, somewhat irregular. Plant apparently sterile, as old fls. seem to drop off, and the people say it never sets fruit. Planted here, not seen wild." 30-III-1943, Fosberg 20406 (US). — "Tree 20 ft. tall. Cult. in Indian

PLATE LXI



Habit of *Datura candida* (Pers.) Saff. cv. Culebra.

herb garden.” 21-II-1951, *Villarreal* 68 (ECON).—“N. v. ‘Culebra borrachera’. Arbol de 2-2,50 m. de altura. Flores blancas. Los indios mastican sus hojas para embriagarse.” 6-II-1953, *Mora* 1023 (COL).—Sibundoy. “Treelet 25 feet tall. Cultivated in Indian garden. ‘Culebra borrachera’. Used as a divinatory narcotic. Flowers white, anthers yellow.” 30-VI-1953, *Schultes & Cabrera* 20079 (GH). (Cotype *Methysticodendron Amesianum*.)—Santiago. “‘Culebra borrachera’. Arbolito de 2-3 m. de alto. Flores blancas. Cultivado por los indigenas. El liquido resultante por la decocción de las hojas lo toman para alucinarse”. 22-IX-1953, *Fernández* 2641 (COL).—Sibundoy. “N. v. ‘Culebra-borrachero’, ‘Mtzkway borrachera (Kamsá). Arbusto hasta de 4 m.; muy folioso. Flores blancas, péndulas, aromáticas por la noche. Usado por médicos como narcótico, para emborracharse, para resfriados y contra hinchazones. Se reproduce solo por estacas. Se dice que rara vez da frutos, que son cilíndricos, como un banano.” 12-VI-1956, *Idrobo* 2221 (COL).—1.5 km. S Sibundoy. “‘Culebra borrachera’. Medicinal. Arborescent 3 m.; corolla white; not fruiting. Indian garden, very infreq.” 13-IV-1963, 764 (COL, ECON, BISH, K, PASTO, S, US).—Sibundoy. “‘Culebra borrachera’. Tree 3.5 m.; corolla white, not fragrant, emerging irregularly folded. Garden, very infreq.” 26-IV-1963, 888 (ECON).—Sibundoy. “‘Culebra borrachera’. Tree 3.5 m.; unopened calyx bulging at top; corolla white; filaments often bent, anthers seldom straight; no fruits. Garden, very infreq.” 11-VI-1963, 1112 (COL, ECON, BISH, K, PASTO, S, US).—2 km. SW Sibundoy. “‘Culebra borrachera’. Tree 4 m.; flrs. pendulous, corolla white; corolla and filaments often bent irreg. Indian garden, very infreq.” 19-IX-1963, 1391 (ECON).—1.5 km. S Sibundoy. “‘Culebra borrachera’. Tree 3 m.; flrs. pendulous, corolla white, bent. Indian garden, infreq.” 21-IX-1963, 1400 (ECON)—San Francisco. “‘Culebra Borrachera.’ Sparsely branching, brittle shrub, 1.5-2.5 m. Flowers white. Infusion of leaves taken as hallucinogen. Found only in cultivation.” 22-VIII-1964, *Olday* 639 (ECON).

Datura ‘Andrés’ n. cv.

Leaves lanceolate to narrowly elliptic, ratio of width to length .334-.443; calyx 11.6-18 cm., terminating in 2-5 lobes; corolla nearly the longest known in the genus, 31.3-43.2 cm., the slender basal part of the tube exceeding the calyx, the corolla teeth 3-5.8 cm., the limb only slightly recurved; anthers distinct, 31-36 mm., stamens very long, 25.7-31.6 cm., pistil with 1-3 pronounced

curves in the region of the anthers, exceptionally long, 32.8–39.8 cm.; not known to fruit.

Selecting seven characters which most frequently distinguish *D. candida* from *D. suaveolens*, I find that in three, the leaf shape, calyx apex and corolla tooth length, 'Andrés' is intermediate. In the length of its corolla and the conspicuous slender basal part of the tube, it is similar to *D. suaveolens*, but the calyx width and free anthers are like those of *D. candida*. The S-curved style is unique among the tree *Daturas*. There seems little alternative for the present but to interpret cv. Andrés as a hybrid between *D. candida* and *D. suaveolens*.

Common names: *Andaquí borrachera*.

Andaquí is the name of a now almost extinct Indian tribe to the northeast at the head of the Magdalena Valley. The area lies many days' journey away, mostly through the eastern lowlands.

On the assumption that 'Andrés' is a hybrid derivative of *D. suaveolens*, a lowland species not known to occur in the Valley of Sibundoy, it is probable that it was brought to the Valley from the eastern lowlands, or possibly directly from the Upper Magdalena area of the Andaquí people. In the immediate eastern lowland area, *Datura* is represented by several collections (*Klug* 1889, A, GH, NY, US; *Cuatrecasas* 10752, US; *Schultes* 3472, GH) which resemble 'Andrés' but have connivent anthers and lack a curved style, and thus approximate *D. suaveolens* more.

Reference to *Datura dolichocarpa* (Lagerh.) Safford in the Valley of Sibundoy (36) is probably to *D. candida* 'Andrés'.

COLOMBIA: Comisaría del Putumayo, Valle de Sibundoy, alt. 2200 m.—San Andrés. Shrub 2.5 m.; corolla white. Border, infreq. 18-III-1963, 650 (COL, ECON, PASTO, US).—San Andrés. Arborescent 3 m.; corolla white; style with S-curve in region of anthers. Roadside, infreq. 20-VIII-1963, 1314 (ECON).—2 km. SE Sibun-

doy. “ ‘Andaqui borrachera’. Tree 2.5 m. ; corolla pendulos, white. Indian garden, very infreq.” 10-X-1963, 1449 (ECON).

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DE PLANTIS TOXICARIIS E MUNDO NOVO TROPICALE COMMENTATIONES V

Virola as an orally administered hallucinogen

BY

RICHARD EVANS SCHULTES

IN 1954, the source of a new hallucinogenic snuff from the northwest Amazon was identified as the resin of several species of the myristicaceous genus *Virola* (17). The species employed amongst Indians of the Amazonian region of Colombia were *Virola calophylla* Warburg, *V. calophylloidea* Markgraf and probably also *V. elongata* (Benth.) Warburg.

Additional but often rather vague reports seemed to indicate that this same kind of snuff was prepared and utilized in the headwaters of the Orinoco in Venezuela (15, 27, 29) and to the north of the Rio Negro of Brazil (4, 8, 9, 14, 27). Eventually, specimens and photographs documented the use of *Virola*-bark for this purpose in that part of Brazil (24). Finally, in 1968, a detailed ethnotoxicological study of these myristicaceous snuffs (23) showed that the species employed, apparently to the exclusion of others, by diverse groups of Waiká Indians of northern tributaries of the Rio Negro in Brazil is *Virola theiodora* (Spr. ex Benth.) Warburg.

In the absence of phytochemical analysis of the snuff or of the resin from which it was made, the identity of the active principle of *Virola calophylla* and *V. calo-*

phylloidea was not known, and the suggestion that the psychoactive properties of the snuff might be attributable to myristicine or some component of it was offered (17). Recent investigation of *Virola theiodora*, however, has shown that the resin is rich in tryptamines (2). The *nyakwana* snuff of the Waikás, prepared from resin of *Virola theiodora* with no admixture, contains approximately 8% of 5-methoxy N, N-dimethyltryptamine, N, N-dimethyltryptamine and traces of other tryptamines (2).

Because of similarity of the psychoactivity of the snuff prepared from *Virola theiodora* and that from *V. calophylla* and *V. calophylloidea*, there is now every reason to presume that the latter two species owe their effects to the same or similar tryptamines as those found in the former. These compounds have also been indicated in an analysis of the bark of *Virola calophylla* (13).

As a result of recent chemical studies, *Virola* must now be added to the list of South American hallucinogens the effects of which are due to tryptamines. These tryptaminic narcotics include *Anadenanthera peregrina* and other species of this leguminous genus; *Mimosa hostilis*; *Banisteriopsis Rusbyana*; *Psychotria psychotriacifolia*; and possibly *Justicia pectoralis* var. *stenophylla*.

Recent field work in the vicinity of Leticia, Colombia, on the Amazon River, has uncovered an interesting new method of employing myristicaceous resin orally as a psychotomimetic agent.

In February, 1969, I was engaged in collecting for phytochemical study several species of *Virola* along the Río Loretoyacu near Leticia. One of my native assistants was a Witoto Indian—Luis Vargas Martínez—who had lived in this region for more than 25 years and with whom I had worked over a number of years. He is a native of El Encanto on the Río Karaparaná, an affluent of the

PLATE LXII



Area of the Colombian Amazon inhabited by the Witoto Indians.

Río Putumayo, which, with its parallel river, the Igaraparaná, comprises the major centre of the Witoto Indians (5, 12, 20, 25, 26). As a result of the nefarious and merciless exploitations and slaughter of these Indians during the wild rubber boom, this region attracted, at least fleetingly, world-wide attention in the early part of the present century. The past 40 years, with missionary contacts, have seen a gradual acculturation of the Witotos, and many of their beliefs and customs have been altered or have disappeared. This acculturation may possibly explain our delay in discovering such an interesting and unique method of preparing and utilizing *Virola*-resin as an hallucinogen.

During the collecting of the bark from several species of *Virola*, this Witoto assistant informed me that the Witotos of his father's generation ate pellets made of *cumala* resin when they wanted to "see and converse with the little people". *Cumala*, a Peruvian name for several species of *Virola*, is employed in the Trapecio Amazónico—the Leticia area. The assistant informed me that the species of *Virola* which his people employed did not exist or was very rare in the Río Loretoyacu area, but he did describe it as a medium-sized tree, slender, growing well above the flood-lands on *tierra alta*. The leaf, according to the informant, is "dry" to the appearance, measuring about six inches in length, with undulating margins. The bark, from which copious red resin exudes, is thin, light brown. The Witoto name of the tree in the Río Karaparaná is *oo-koó-na*.

While it was impossible for us to collect a voucher specimen in the Río Loretoyacu, I believe that the species represents *Virola theiodora*. In 1942, amongst the Witotos of the Río Karaparaná region, I collected (*R. E. Schultes 3878*¹) *Virola theiodora* with the annotation that

¹ Comisaría del Amazonas, Río Karaparaná, along path from El En-

it was "intoxicating". I could get no further information at that time. The Witoto name of this plant in the Río Karaparaná was *oo-koó-na*, the same name given to me by the informant, but this Indian name may refer generically to more than one species of *Virola* or even to species in related genera. A collection (*R. T. Martin et C. A. Lau-Cam 1272*) of *Dybalanthera parviflora* from the Río Napo in adjacent Peru, for example, bears the Witoto name *u-kú-na*.

The Witotos rasp the inner part of the freshly stripped bark, roll the rasped tissue into balls and express the resin from it into a pot of water which is boiled for five or six hours, until the mass becomes a thick syrup that sticks to the wooden paddle that has been used to stir the boiling mixture.

While this operation is progressing with the resin of *Virola*, another Indian reduces to ashes the bark of a "large tree with long leaves, like *matamatá*" that grows in floodland. We were fortunate in being able to collect flowering material of this tree in the Río Loretoyacu region: it represents *Gustavia Poeppigiana* Berg ex Martius.² The Witoto name of this tree is *hě-rog*.

The ashes are placed in a funnel made of strong leaves, and cool water is poured over the ashes and allowed to seep through until "no more cloudiness leaches out". The water is then slowly boiled down until a greyish residue or "salt" is left. This is known in Witoto as *le-sa*.

canto to La Chorrera. "Small tree. Height 40 ft. Red resin in bark. Intoxicating. Witoto: *oo-koó-na*". May 31-June 2, 1942. *R.E. Schultes 3878*.

²Comisaría del Amazonas, Río Loretoyacu, 3 km. above Puerto Nariño. In lowland forest. "Tree 7 m. tall. Leaves dark green, shiny. Petals white, stamens yellow. Fruit green, seeds germinating within ripe fruit." January 28-February 7, 1969. *T. Plowman, T. Lockwood, H. Kennedy et R.E. Schultes 2432*.

The thickened *Virola*-resin is then rolled with the fingers into tiny pellets the size of coffee beans, and these are rubbed in the salt-like residue from the leached-out lecythidaceous bark ashes. The pellets, thus coated, are ingested whole or dissolved in water and drunk. From three to six pellets—called *oo-koó-hě*—are taken initially, and the intoxication is said to begin within five minutes and last up to two hours. More pellets may be taken when the effects of the drug begin to lessen in intensity.

According to my informant's description, all kinds of visual hallucinations are experienced. The narcotic is taken usually in a group comprising from three to eight or more men, normally including the *payé* or witch-doctor. Only the *payé* may take the initiative in preparing the drug. It is taken not regularly but at irregular intervals when the need arises, and only for divination, to "see and converse with the little people", to prophecy, to find lost property, to "study", to "talk with" people from other tribes over great distances and to ensure luck in the hunt.

Dr. Horacio Calle, anthropologist at the Universidad Nacional de Colombia, has recently sent me some very interesting data and botanical specimens collected from informants of the Muinane tribe, now living in the vicinity of Leticia. These Indians lived originally in the Karaparaná-Igaraparaná-Kahuinarí area, the general region inhabited by the Witotos.

According to Calle, the Muinanes call the *Virola* tree *kutrucu* and the drug prepared from its resin *kutru*. The related Bora tribe likewise knows the narcotic which, in their language, is *kurru*.

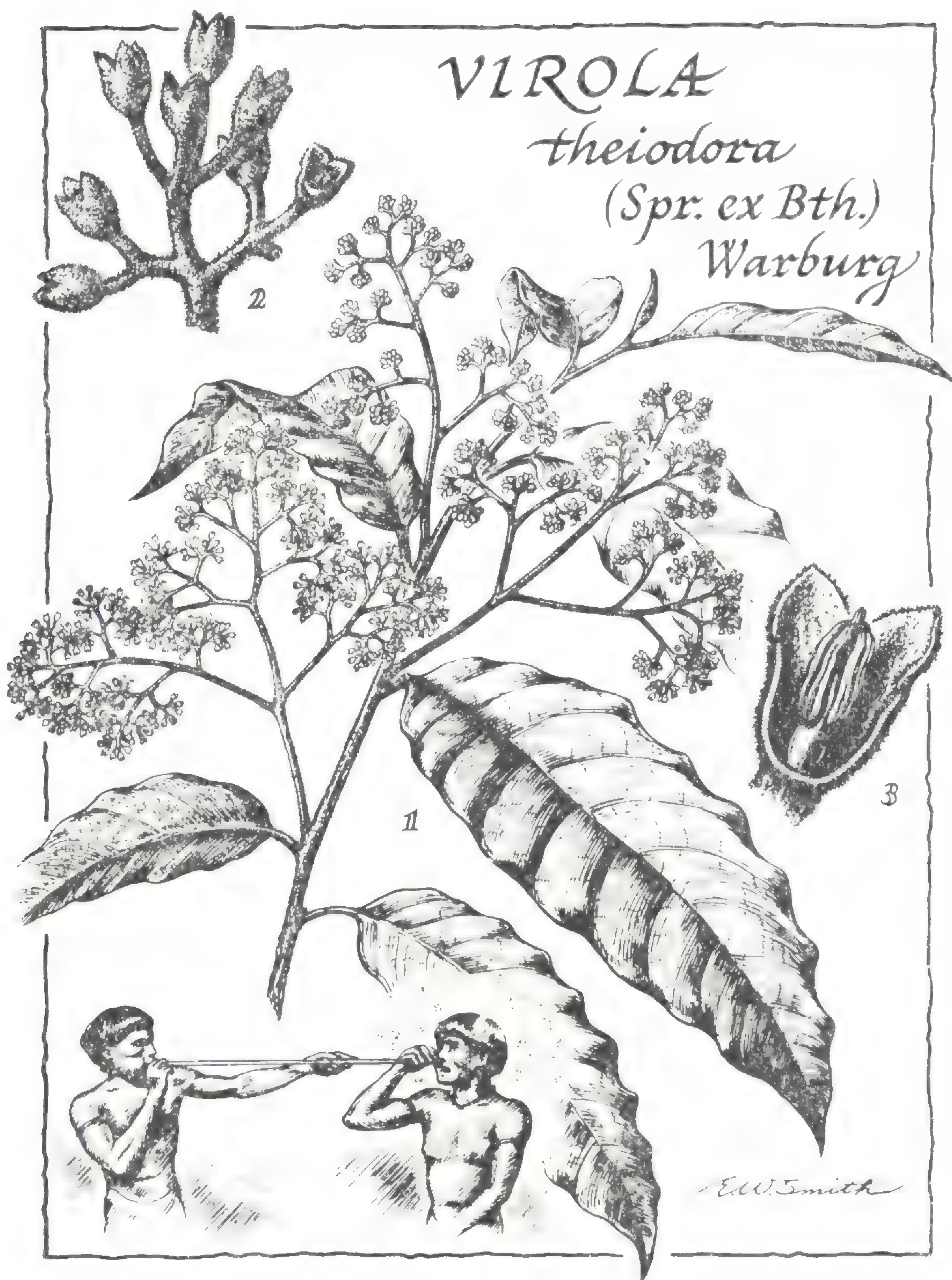
Several very young leaves, collected by Calle, are difficult to identify as to species. According to Calle, botanists at the Instituto de Ciencias Naturales in Bogotá

VIROLA

theiodora

(Spr. ex Bth.)

Warburg



tentatively referred them to one of the following species: *Virola elongata*, *V. peruviana* (A. DC.) Warburg or *V. calophylloidea*. His Indian informant stated that there are several "kinds of *ucuna*, some with leaves larger than others", but that the tree with the smallest leaves is "the true *ucuna*", i.e., meaning probably the *Virola* employed to prepare the hallucinogen. These *Virola* leaves which Calle collected are now preserved in the Economic Herbarium of Oakes Ames and appear to me possibly to represent *V. calophylloidea*.³

The data concerning the admixture which Calle reports are perhaps even more interesting. In preparing the pellets for ingestion, the Muinane informant stated that the *Virola*-bark, freshly stripped from the tree, is crushed and boiled in water, until the liquid is thick and of a honey-like consistency. This syrup is then mixed with ashes of the rind of fruit of a species of *Theobroma* or of the dried leaves of a palm, *Mauritiella aculeata* (HBK.) Burret. The mixture is then rolled into soft, brownish pellets.

It would seem, thus, that there is some variation in the methods of preparing the drug. Further field work in the original home region of these Indians will be necessary for a full understanding of this interesting hallucinogen.

Interest in this newly discovered hallucinogen does not lie wholly within the bounds of anthropology and ethnobotany. It bears very directly on certain pharmacological matters, and, when considered with other plants with psychotomimetic properties due to tryptamines, this new oral drug poses problems which must now be faced and, if possible, toxicologically explained.

It is generally accepted pharmacologically that the pure compound N, N-dimethyltryptamine is inactive

³ Comisaria del Amazonas, 8 km. north of Leticia. Muinane name: *kutruku*. April 1969. H. Calle sin. num.

when administered orally, unless accompanied by a monoamine oxidase inhibitor (6). The tryptamines—especially N, N-dimethyltryptamine—are the active constituents of hallucinogenic snuffs of South America (2, 6, 13, 22, 27) prepared from *Anadenanthera peregrina* (yopo), *A. colubrina* (huileca) and *Pirola theiodora* and probably other species (yakee, epená, nyakwana, paricá) (22). Yet the narcotic *vinho de yurema*, prepared from the roots of *Mimosa hostilis* (11), the active constituent of which is N, N-dimethyltryptamine, is extremely active when taken orally. It has furthermore recently been learned that the two common admixtures of the ayahuasca, caapi or yajé drink prepared basically from bark of either *Banisteriopsis Caapi* or *B. inebrians*, rich in harmala alkaloids, are leaves containing N, N-dimethyltryptamine: *Banisteriopsis Rusbyana* (1, 6, 16) and *Psychotria psychotriaefolia* (7). There is no question but that the addition of leaves of *Psychotria psychotriaefolia* and especially of *Banisteriopsis Rusbyana* very strongly enhances the color visions, increases the intoxication and prolongs the narcotic effects of the drink. In the case of these two admixtures, it is clear that, when added to a beverage containing the harmala alkaloids, harmine and harmaline, they would be in the presence of monoamine oxidase inhibitors. As has recently been suggested, “. . . perhaps this fact, coupled with the presence of small amounts of related isomers, may help account for the effectiveness of the crude preparation. . .” or “perhaps the strong concentration of active principles or the presence of other unidentified substances facilitate absorption” (6).

In the instance of yurema, which is prepared apparently from the roots of *Mimosa hostilis* with no admixture whatsoever, a monoamine oxidase inhibitor might possibly be present, but we do not yet know. With the orally administered *Pirola*-resin of the Witotos, one

must assume that the tryptamine acts without such an inhibitor or else that the residue from the leaching of the lecythidaceous bark-ashes contains a monoamine oxidase inhibitor.

All of this points out with singularly insistent emphasis the wisdom of an interdisciplinary approach in the search for new psychoactive drugs, since the value of folklore data has so often in recent studies been indicated (18). It points further to the urgency of intensive ethno-toxicological study of folklore in view of the rapid disintegration and disappearance of aboriginal cultures around the world (19, 21).

The field work during which the discovery reported in this paper was made was financially supported in part by the Bache Fund of the National Academy of Science, to which source grateful acknowledgment is herewith offered.

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BOTANICAL MUSEUM LEAFLETS

HARVARD UNIVERSITY

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VOL. 22, No. 7

A NEW AMAZONIAN ARROW POISON: *OCOTEA VENENOSA*

BY

A. J. KOSTERMANS,¹ HOMER V. PINKLEY,²
AND WILLIAM L. STERN³

A RECENTLY discovered ingredient of arrow poisons used by the Kofán Indians of the westernmost Amazon in Colombia and Ecuador is produced by an undescribed species of *Ocotea* of the Lauraceae.

Ocotea venenosa *Kosterm. et Pinkley sp. nov.*

Arbor ramulis cum innovationibus dense minutissime ferrugineo-pilosis; foliis spiraliter alternantibus vel suboppositis, chartaceis, ellipticis, obscure acuminatis, basi in petiolum brevem contractis supra laevibus, nervo mediano prominulo, costis filiformibus vix prominulis, subtus dense prominule reticulatis, nervo mediano prominenti, dense pulverulente piloso, costis utrinque ca. 9 subpatentibus prominulis; inflorescentiis paniculatis, axillaribus, parvis, dense minutissimeque ferrugineo-pilosis; floribus tantum in alabastrum cognitis; tepalis ovatis; staminibus fertilibus 9, crassis, exterioribus loculis 4 magnis, introrsis, filamentis crassis, interioribus loculis 4 extrorsis; glandulis non vidi; ovario subpiloso, ellipsoideo, in sty-

¹ Herbarium Bogoriense, Bogor, Indonesia.

² Botanical Museum of Harvard University, Cambridge, Mass.

³ Department of Botany, University of Maryland, College Park, Md.

lum brevem prodeuntibus; fructu depresso-globoso, magno in cupulo magno incluso.

COLOMBIA: Comisaría del Putumayo, Río Guamúes, Santa Rosa. Primary forest. Altitude about 1060 feet. Long. $77^{\circ}05'$ W, Lat. $00^{\circ}19'$ N. November 26, 1966. *H.V. Pinkley 555* TYPE! (TYPE in Herb. Gray. DUPLICATE TYPE in Econ. Herb. Oakes Ames; Utrecht; Naturhistoriska Riksmuseet, Stockholm).—ECUADOR: Provincia del Napo, Río Aguarico, Durero. "Fruit used to make arrow poison. Wood, yellow, very hard and bitter to taste. Sterile". October 26, 1966. *H.V. Pinkley 538*.

Tree 32 m., bole 20 m., diam. 70 cm.: branchlets and terminal bud densely and minutely rusty-pilose. Leaves spirally arranged, occasionally subopposite, chartaceous, coriaceous, glabrous except above the midrib underneath, elliptical or narrowly elliptical, $6-9 \times 16-20$ cm. obscurely acuminate, base contracted into petiole 8-12 mm. long, flattened above; upper surface smooth, glossy, midrib conspicuous, prominent, lateral nerves filiform, hardly prominent; lower surface glossy, densely, minutely, and rather obscurely reticulate. Midrib prominent, densely pulverulent-pilose, lateral nerves ca. 9 pairs, rather patent, slightly arcuate, prominent. Panicles (immature) axillary, up to 2 cm. long, densely, minutely rusty-pilose. Flower buds ca. 1.5 mm. in diam.: tepals ovate, fleshy, acutish, equal, or the inner ones narrower. Fertile stamens 9, thick, 4-celled; outer ones with large introrse and introrse-lateral cells, the anther not differentiated from the thick filament; the inner row with similar but narrower stamens with extrorse cells; the connectives blunt, protruded beyond the cells. Glands not seen. Ovary and style as long as the stamens, the ovary ellipsoid, merging into a slightly shorter style with rather inconspicuous stigma. Fruit depressed-globose, 5.5 cm. diam., 4.5 cm. high, smooth, with a small notch at the apex; cup 1 mm. thick, obscurely, broadly ribbed, covering the entire fruit except the up-

per part, leaving an orifice of 2.5 cm. diam.; the cup closely adpressed to the fruit. In a smaller fruit (4.5 cm. diam.) the orifice of the cup is 3.5 cm. in diam. Stalk thick, woody, very short, 6 mm. diam.; cotyledons plane-convex, thick; plumule, and radicle basal.

Most of the flower buds available for dissection were abnormal as a result of fungal attack. The fruit cup is unusual in *Ocotea*, because it is almost adnate to the fruit. Another peculiarity is that the fruit does not protrude from the cup. This is rare in *Ocotea*, but it does occur in other genera of the Lauraceae.

The Kofán Indians, a tropical rain forest tribe of eastern Ecuador and Colombia, employ the fruit of this plant, *gĩngivé 'k'o* in Kofán, as an ingredient in one of their arrow poisons. Hence, the specific epithet, which means "very poisonous" in Latin, was chosen for this large tree. Two trees had to be felled before fertile material was found. After felling the first tree, which was sterile, I (Pinkley) took bark of the tree to my hut, thinking that it was the part of the tree used in preparing the arrow poison. When I arrived with the bark, the Indians laughed and revealed that they use only the fruit.

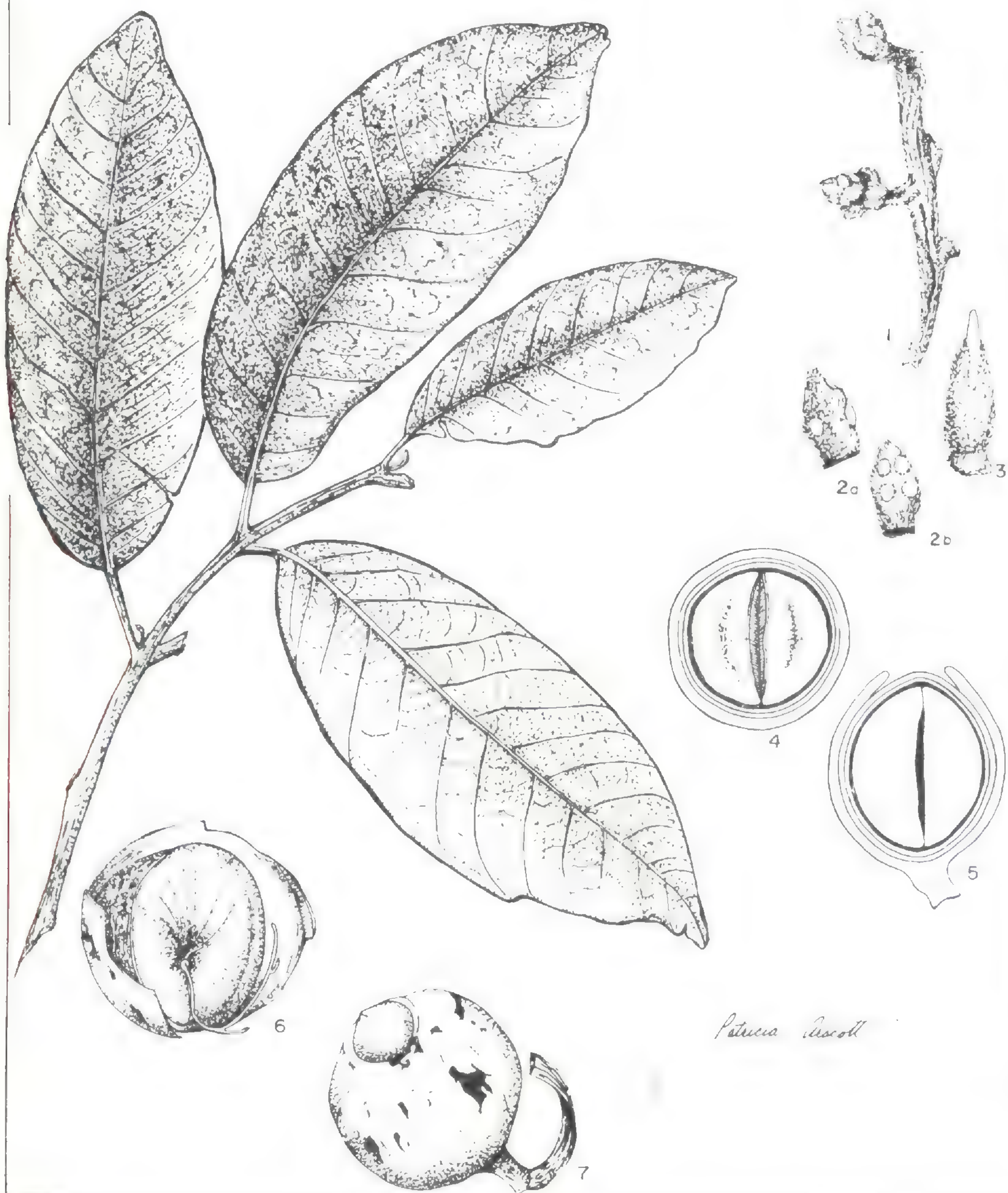
Chemical analysis and pharmacologic research of this new species is being carried out by Dr. Ara Der Merderosian of the Philadelphia College of Pharmacy and Science. He reports, through personal communication, that he has isolated two of several alkaloids present, rodiasine and demethylrodiasine related to the curare alkaloid of medicine, d-tubocurarine. Rodiasine was first isolated in crystalline form from *Ocotea Rodiei* (Rob. Schomb.) Mez (*Nectandra Rodiei* Rob. Schomb.), (4, 7). The alkaloid study of *Ocotea Rodiei* began much earlier, however, when MacLagan in 1843 separated the alkaloids of this plant into two amorphous fractions, calling the portion soluble in ether bebeerine, and the portion in-

soluble in ether sepeerine. Since Maclagan's classic study, the name bebeerine, however, has been variously defined resulting in much confusion (7). Since he isolated amorphous fractions rather than crystalline compounds, most are in favor of abandoning his nomenclature and using coined names referring only to actual isolated compounds. Hence, though Maclagan's bebeerine may be, in fact, the same or related to rodiasine, the term rodiasine is now preferred. Maclagan was encouraged to study the chemistry of *Ocotea Rodiei* not because of any known curarizing effect but because the wood was known to be highly resistant to insects, marine borers and fungal decay (5, 8). Today we know that curine, the *l* form of "bebeerine," in high concentration ". . . causes paralysis of the striated muscles and paralysis of the nerve end plates" (6). Though the chemical constituents of *Ocotea venenosa* and *Ocotea Rodiei* appear to be similar, the initial chemical investigations were induced for two different reasons.

Several plants of the Lauraceae with an alkaloid related to "bebeerine" were reported in 1890 by Greshoff, a pioneer in phytochemistry. Greshoff found in several genera an alkaloid which he called "lauro-tetanine." He stated that (transl.), "according to the important characteristic, . . . causing tetanus in several species of animals, I propose to give this body which can be crystallized and characterized by good reactions the name lauro-tetanine" (3). He furthermore recognized the similarity of lauro-tetanine and bebeerine and suggested that (transl.) "a detailed quantitative research of bebeerine seems one of the most urgent desiderata of the alkaloid studies" (3).

Other alkaloids with curarizing effects have been isolated from the lauraceous tree *Cryptocarya Borzici* (Hooker) Druce of Australia (2). The poisonous nature of this plant was discovered, quite by accident, by T. L. Bancroft in 1886. He related his experience: (1)

OCOTEA venenosa *Kosterm. et Pinkley*



Ocotea venenosa. Habit sketch of branchlet, $\times \frac{1}{3}$. 1, inflorescence branchlet, $\times \frac{1}{3}$. 2, 2a, outer stamen, $\times 15$. 2b, inner stamen, $\times 15$. 3, ovary and style, $\times 20$. 4, diagrammatic cross section of fruit, $\times \frac{1}{3}$. 5, diagrammatic longitudinal section of fruit, $\times \frac{1}{3}$. 6, oblique angle of dissected fruit showing large cotyledon and developed root, $\times \frac{1}{3}$. 7, fruit, $\times \frac{1}{3}$.

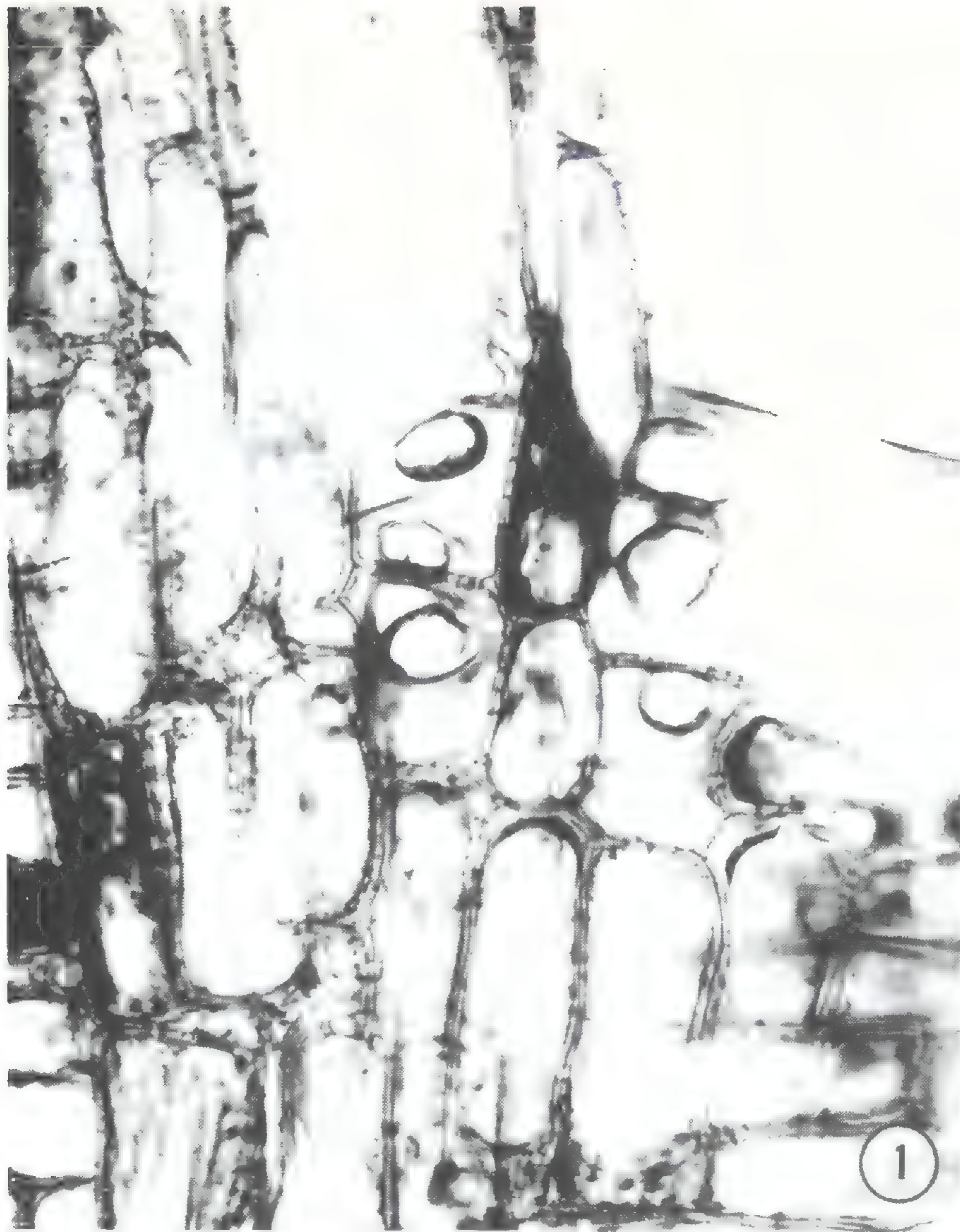
On May 12th, 1886, in search of poisonous plants I found the bark of this tree to have a very persistently bitter taste. Physiological experiments were immediately made, which led to the discovery of its toxic action. Other species of the same genus are likewise poisonous. It is interesting botanically to note such a poisonous genus in this order.

The alkaloid or its salts have an intensely bitter taste; it is odourless and extremely poisonous, slightly soluble in water, very soluble in alcohol, ether, and chloroform. Warm blooded animals poisoned with *Cryptocarya* exhibit respiratory difficulty, soon ending in asphyxial convulsions and death. On frogs it causes paralysis of the reflex function of the spinal cord and the peripheral ends of motor nerves as effectually as curara.

The fact that Bancroft was led to make further studies because of the very persistent bitter taste has an interesting parallel among the Kofán Indians. Most, if not all, of the plants which they use in preparing arrow poisons are bitter. Equally true, one of the first diagnostic characters used by the Kofáns in identifying a plant is its taste. After first tasting the bark of a tree, for example, they will look up into the forest canopy and try to find leaves associated with the tree. It is quite possible that bitterness, *inza'tsi* in Kofán, led to the original discovery of the plants used for their arrow poisons. Moreover, in many cultures bitterness has become associated with death. An association which may have resulted from primitive man's observation that many bitter plants can cause death.

XYLEM ANATOMY OF *Ocotea venenosa*

Pores are decidedly rounded and occur mostly in the solitary (76%), radial multiple (20%), and clustered (4%) distributions. Radial multiples usually comprise only 2 pores, 3- and 4-pored multiples being rather uncommon. Only 3-pored clusters were noted. Tangential pore diameter ranged from 87μ – 155μ with an average of 117μ , based on measurements of 50 pores. Vessel elements all



1



2

1, radial section of xylem showing fenestriform pitting between vessel elements and xylem parenchyma, $\times 290$.
 2, coronated vessel element from macerated material illustrating fenestriform pits at ends, $\times 140$. Note: Perforations in this vessel element are out-of-focus.

contain simple perforations. Occasional vessel elements with three perforations were noted. Ligules may be present and are usually short or they may be absent from the ends of vessel elements. Intervascular pitting is alternate; inner apertures of pits are horizontally elongate and are enclosed by borders which may be elongate, rounded, or polygonal; adjacent inner apertures may be crossed or coincident. Vessel elements range in length from 235μ – 935μ and average 564μ in length, based on 50 measurements.

The relationship between vessel elements and axial and ray parenchyma cells presents a curious if not unique situation in this species. Both kinds of cells are interconnected with adjacent vessel elements through unilaterally compound pitting with very large simple pits in parenchyma cells subtending two or more bordered pits in vessel elements. The large simple pits in the parenchyma cells are often traversed by branched or simple filiform processes of cell wall material. In addition to the unilaterally compound pitting, half-bordered pits occur. Supplementing these more or less common kinds of pitting is the pitting in the coronated vessel elements. These vessel elements are normal in appearance in all respects except that upper and lower ends bear a complete or partial ring of large, fenestriiform, obscurely bordered pits which give the impression of a crown or corona (Plate LXIII, fig. 2). These are associated with simple pits of similar size and form in adjacent ray and axial parenchyma cells (Plate LXIII, fig. 1). Pits of the corona may be square, rectangular, triangular, oval, elliptical, or irregular. At times these pits occur on ligules as well. The uniqueness of this pitting resides in its position at upper and lower ends of vessel elements, its vessel element encircling tendency, and the large size of the pits. All combine to impart a crown-like appearance to the ends of vessel elements

For all intents and purposes, the imperforate tracheary elements are libriform wood fibers. Inner apertures of pit-pairs are somewhat elongated and outer apertures are nearly circular. A minute, insignificant border may be observed under high magnification in some pits of some fibers. Walls are very thick ranging up to 8μ . Lumina are equal to or less than the diameter of the walls and are often completely occluded by the growth of the secondary cell walls. Fiber length ranges from 750μ – 1437μ and averages 1104μ , based on 50 measurements.

Vascular rays range from 1–4 cells wide, 1-seriate and 4-seriate rays being rare. Ray height ranges from one cell to over 25 cells, most rays being lower than 15 cells high. Rays are heterocellular with the terminal ray cells being square, squarish, or upright and with the body of the ray comprising only procumbent cells. Terminal ray extensions are ordinarily one or two cells high with uni-seriate extensions rarely reaching five or six cells high. These cells are slightly swollen as viewed in tangential section.

Axial parenchyma is always paratracheal and may consist of a vasicentric sheath one to several cells wide around vessels and vessel groups; it may be aliform with short, broad wings; or sometimes it is even aliform-confluent.

No secretory cells were observed in the secondary xylem.

Because of the unusual nature of some of the morphological features of *Ocotea venenosa*, namely, the fruit, the third author felt that an investigation of the secondary xylem might be instructive. Other than the exceptional coronated vessel elements described above and the somewhat unusual absence of secretory cells, at least in the specimen examined, the xylem of *O. venenosa* falls well within the range of the xylem anatomical characteristics of Lauraceae described by Stern in 1954 (9). In that

work, several species of Lauraceae were noted as lacking secretory cells in the secondary xylem, namely : *Dehaasia triandra*, *Lindera Benzoin*, *Nectandra coriacea*, *N. globosa*, *Neolitsea Levinei*, and *Ravensara crassifolia*. Secretory cells were described as scarce in *Ocotea palmana*, *Hypodaphnis Zenkeri*, and *Laurus nobilis*. The absence of secretory cells in the secondary xylem of *O. venenosa* cannot alone be used to rule out or render questionable the demonstrated taxonomic affinities of this species.

The peculiar fenestriiform pitting in vessel elements represents a unique specialization occurring only in this particular species, at least as far as is presently known. Whether or not the combination of the unusual fruit (for *Ocotea*, anyway) and the special coronated vessel elements are significant enough characteristics upon which to base a new genus of Lauraceae, will depend upon the judgment of taxonomists.

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BLANCHE AMES AMES
(1878 -1969)

AN APPRECIATION

THROUGH most of her long life, Blanche Ames Ames cherished a unique and meaningful relationship with the Botanical Museum, a closeness severed only by death at her home in Borderland, North Easton, Massachusetts, on March 1, 1969.

Wife and lifelong helpmeet of Professor Oakes Ames, second director of the Botanical Museum, Blanche Ames never held an official appointment as a member of the Museum staff. Nevertheless, her contributions to the life of the institution were so profound that they will always be appreciated in the educational and research activities of the Museum and, through it, will continue to be widely recognized in the world of botany.

Mrs. Ames was an early champion of women's suffrage, a leader in civic and charitable affairs and an author; but perhaps she will be most widely acknowledged as an artist. Her botanical etchings and pen and ink drawings are displayed in the Botanical Museum and in the Metropolitan Museum of Art, and her oil paintings hang at Harvard, Dartmouth, Columbia, Phillips Exeter Academy, the Mississippi State Hall of Governors and in several private collections.

Her interest in botanical artistry began when, at the Ames Botanical Laboratory at North Easton, she started

to illustrate her husband's publications on new species of Philippine orchids. When Professor Ames transferred his activities to the Museum and installed there the Ames Orchid Herbarium and Library, she intensified her efforts, producing over a period of some fifty years literally hundreds of outstanding line drawings of orchids. When the University added the supervision of the Arnold Arboretum to Professor Ames' duties, Mrs. Ames undertook the preparation of drawings of a number of horticulturally important shrubs.

In the 1920's, Professor Ames turned his attention to economic botany, and his wife began to illustrate plants of use to man. Especially noteworthy was Mrs. Ames' preparation, under her husband's guidance, of the now famous "Ames Charts of Economic Plants". The teaching of Harvard University's course in Economic Botany, offered for many years by Professor Ames, was organized around these four colorful wall charts depicting important economic species arranged on a "phylogenetic tree", in accordance with the Engler-Prantl System. Still in use to-day, the charts have helped interpret plant classification to hundreds of students for more than fifty years and have stamped a unique character on Harvard's teaching in this interdisciplinary field.

When Professor Ames established a press in the Museum in the early 1930's and initiated publication of the *Botanical Museum Leaflets, Harvard University* and occasional books, Mrs. Ames' artistry vitalized the research papers that were printed. Among the books produced on this press and illustrated by Mrs. Ames are "Orchids in Retrospect", "Drawings of Florida Orchids" and "Economic Annuals and Human Cultures". Her line drawings have likewise been widely reproduced in many monographs, floras and manuals issued by other botanical institutions and by commercial publishers.

Mrs. Ames was an accomplished portrait artist. Examples of this aspect of her artistic contribution, hanging in the Botanical Museum, consist of life-sized oil paintings of the Museum's three directors: Professor George Lincoln Goodale, Professor Oakes Ames, and Professor Paul C. Mangelsdorf. It is unique to have the portraits of three men whose service spanned a period of 79 years—from 1888 to 1967—painted by a single artist.

'Truly a great lady and an outstanding artist, Blanche Ames' influence will long be felt in botany, for she spent a great part of her life interpreting the beauty of plants for others. This characteristic of her life was appropriately stressed at memorial services for Mrs. Ames by the Rev. Mr. Edmund Palmer Clarke of the Unitarian Church of North Easton. "If Mrs. Ames had been a man, we would have said of her that she was 'a man of parts'. . . a person of much ability and many talents. . . Those of you who knew her best will see the aptness of my using the phrase to describe her. Perhaps even better, now that she has gone from us, is Shelley's. . . : 'She is a portion of the loveliness which once she made more lovely. . . ' For this was her greatest talent—to know nature—to reproduce it in her drawings for those less perceptive than she, and to give expression to those things which made us better because she had lived amongst us.'"

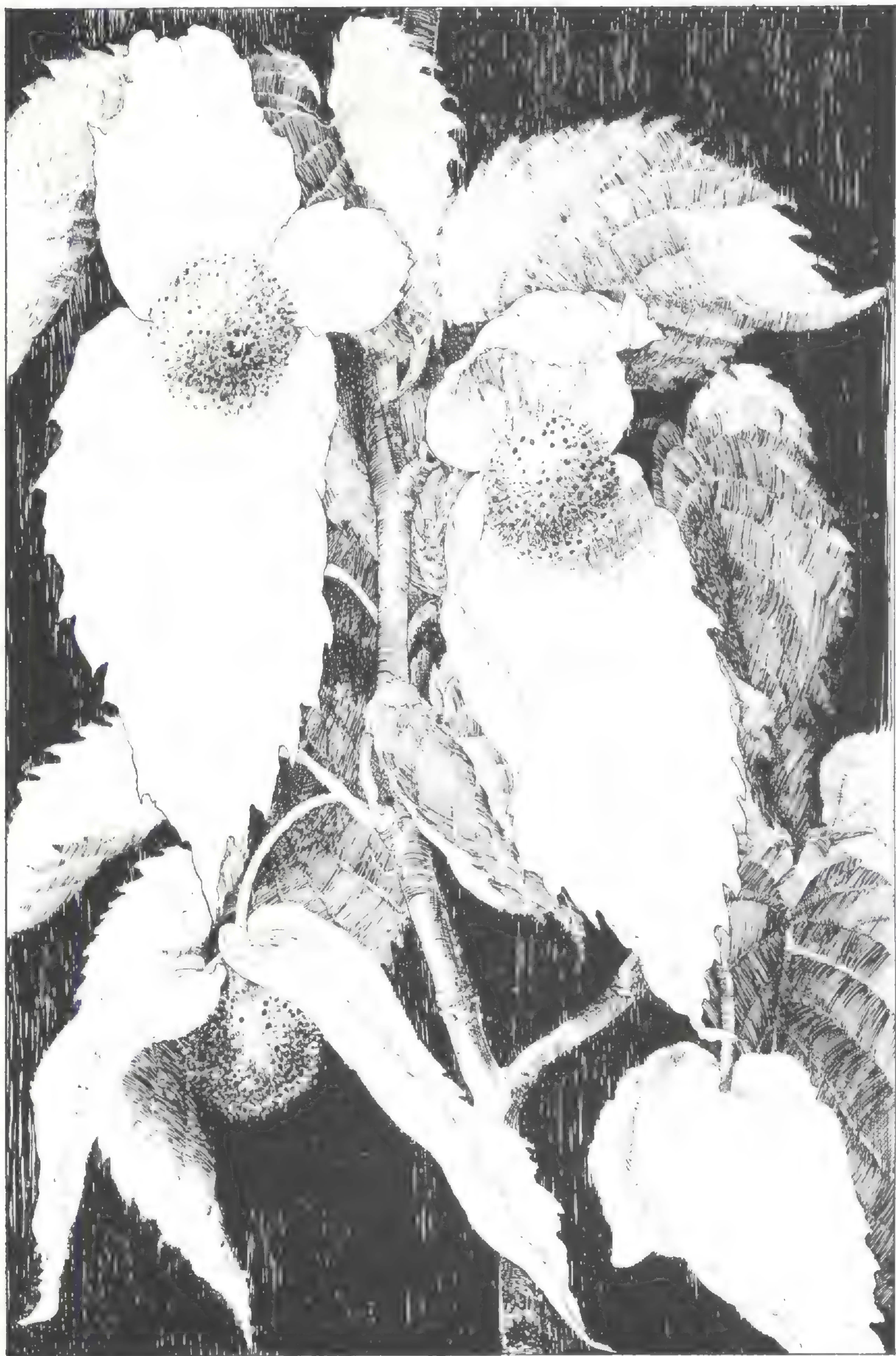
The staff of the Museum can think of no better way of expressing its appreciation of Blanche Ames' devotion to botanical art than to present, on the very press that has known so well her skillful pen, a selection of her artistic and scientific contributions.

—RICHARD EVANS SCHULTES

PLATE LXVI



BLANCHE AMES AMES



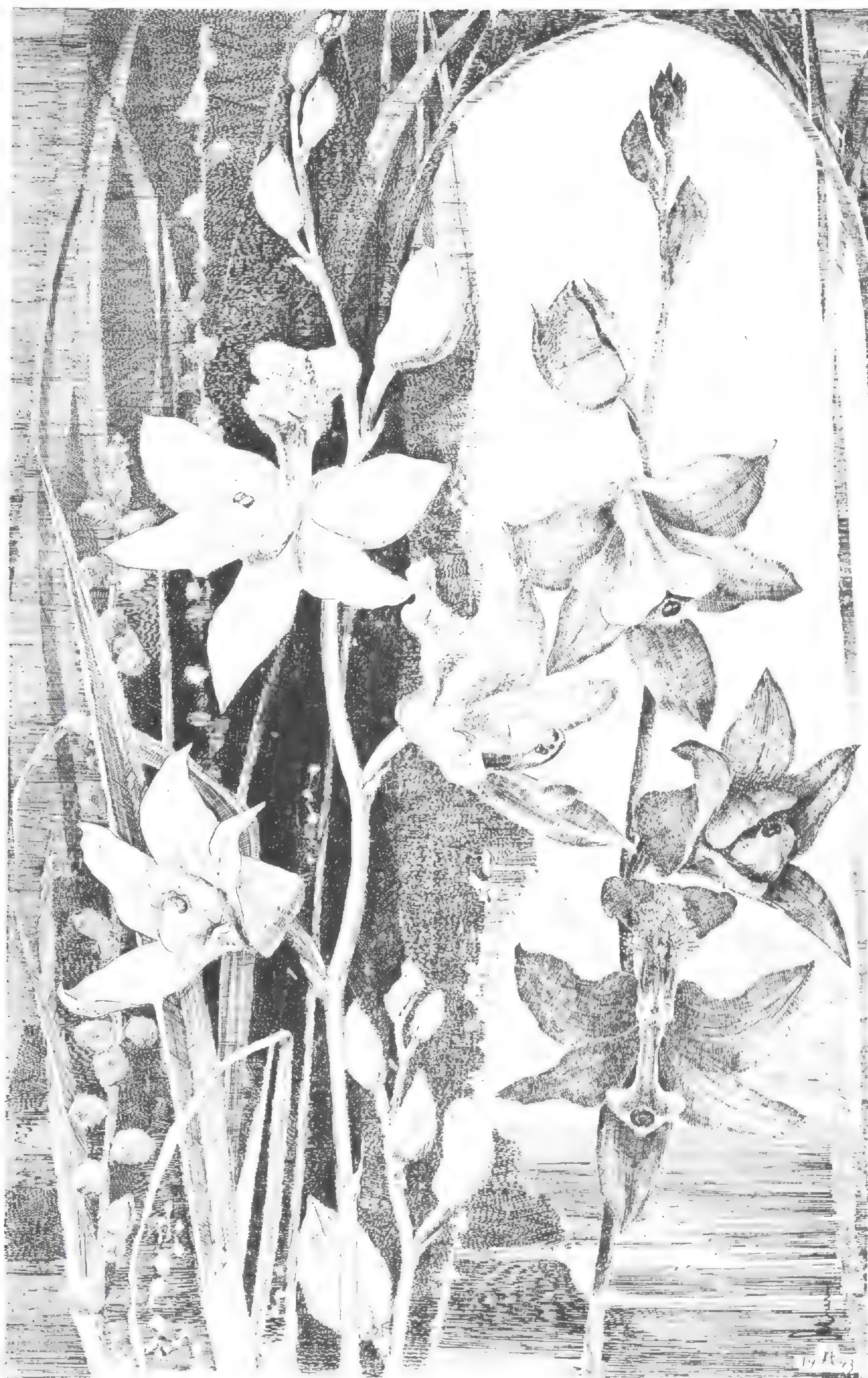
Davidia involuerata *Baill.*
(Dove Tree)

PLATE LXVIII



Polyradicion Lindenii (Lindl.) Garay

PLATE LXIX



Calopogon pulchellus (Salisb.) R. Br.

PLATE LXX



Habenaria nivea (Nutt.) Spreng.



Cypripedium Calceolus *L.*
var. *pubescens* (*Willd.*) *Correll*

PLATE LXXII



Epidendrum tampense Lindl.



Blanche Ames Ames and Oakes Ames



STELIS *pendulispica* Ames

FOUR NEW SPECIES OF SAURAUIA FROM SOUTH AMERICA

BY
DJAJA D. SOEJARTO¹

Saurauia is a widespread genus of the Actinidiaceae (Theales). The members of *Saurauia* are represented in both tropical and subtropical Asia and America. According to the latest estimate made by Melchior,² approximately 280 species of the genus have been described. The American distribution of *Saurauia* extends from central Mexico in the north to Bolivia in the south, through Andean South America. Twenty-two species are found in Mexico and Central America,³ and my present study⁴ indicates that 49 species are represented in South America. Members of the genus consist mostly of localized populations of mountainous and subalpine trees and shrubs, but species adapted to lower elevations and species with broad geographic distribution are also known.

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³ Hunter, G.E. 1966. Revision of Mexican and Central American *Saurauia* (Dilleniaceae). Ann. Missouri Bot. Gard., 53 (1): 47-89.

⁴ Studies of South American *Saurauia* (Actinidiaceae), 458 pp., 61 pls., Ph.D. dissertation (1968), Department of Biology, Harvard University, Cambridge, Mass., U.S.A.

Among the collections of South American *Saurauia* kindly loaned to me for study by the United States National Museum, the Gray Herbarium of Harvard University and the New York Botanical Garden, there were specimens which I could not identify with any of the species that I accepted from South America nor with any of those of Mexico and Central America accepted by Hunter. After careful studies of these specimens, I am inclined to believe that these species are new to science.

1. ***Saurauia multinervis*** *Soejarto sp. nov.*

Species foliis magnis elongatis glabris, nervis lateralibus numerosis, inflorescentiis omnino glabris multifloris, sepalis glabris notabilibus.—HOLOTYPE: *Idrobo & Fernández 54* (US).

Shrubs to 2 m., many-branched, glabrous. Leaf blades elongate-obovate, cuspidate at apex, broadly cuneate to obtuse at base, dentate-serrate with minute and sharp-pointed serrations along margins, 30–42 cm. long, 12–14 cm. wide, coriaceous, dirty dark olive-brown above in dry state, brownish olive beneath, laevigate and smooth above, secondary veins 35–37 pairs, tertiary veins elevated, more prominent than lesser venation, both surfaces glabrous: petioles 1–2 cm. long, 3–5 mm. in diameter, glabrous. Inflorescences straight, ca. 150-flowered, 23 cm. long, 15 cm. wide, glabrous, primary peduncle 1.5 cm. long, bracts linear, to 5 mm. long. Flowers unknown. Fruits laxly distributed, berries 5-locular, globose, to 6 mm. in diameter, 5-sulcate, glabrous: pedicels 4–8 mm. long, bracteoles linear, to 3 mm. long: persistent sepals 5, oblong-elliptic to ovate, obtuse, 5–6.5 mm. long, 3–4.5 mm. wide, all glabrous within and without, marginally entire to irregularly ciliolate: persistent styles 5, 4.5–5 mm. long, stigmas capitate.

Distribution: Colombia (Departamento Cauca), alt. 2000 m., fruiting in August.

Vernacular names: *Lulumoco* (Cauca—Idrobo & Fernández).

Specimens examined. Colombia, Cauca: Cordillera Occidental, vertiente oriental, El Tambo, Corregimiento de Chapa, Ciruelas, *Idrobo & Fernández 54* (US).

2. *Saurauia Schultesiana*⁵ *Soejarto sp. nov.*

Species ceteribus differt foliis et inflorescentiis ramuli apice confertis, laminis supra distante et sparse setulosis subtus sparse setosis, inflorescentiis paucifloris (minus quam vigintifloribus), bracteis glabris, pedicellis longis (usque ad 10 mm.), floribus magnis (20–25 mm. latis), sepalis parte mediana parse pubescentibus sed lateralibus glabris, intus omnino glabris, staminibus viginti-quinque ad trigintiquinque.—Holotypus: *Pennell 10501* (NY).

Trees: copiously to sparingly pubescent. Branchlets terete, abundantly pulverulent, rusty strigose to appressed-setose (young leaves and shoot deep brown). Leaves crowded near tip of branchlets; blades elliptic to oblong-obovate, acuminate at apex with acumen to 15 mm. long, cuneate at base, serrulate along margins, 14–18 cm. long, 7–8 cm. wide, subcoriaceous, in dry state dark dirty brown above, greyish olive-brown beneath, scarcely scabrous above and beneath, secondary veins 15–18 pairs, tertiary veins elevated, more prominent than lesser venation, sparingly setulose along and between minor veins and abundantly appressed-setose to strigose along major veins above, sparingly setose to setulose (mixed with

⁵ I have named this species in honor of Dr. Richard Evans Schultes, Executive Director of the Botanical Museum of Harvard University and my former academic adviser, who has inspired in me a deep interest in the tropical American flora.

scattered radiate trichomes) along and between minor veins and abundantly pulverulent strigose along major veins beneath; petioles ca. 2 cm. long, 2–3 mm. in diameter, half-terete, abundantly rusty strigose. Inflorescences distributed near tip of branchlets, straight, 6–20-flowered, 13–30 cm. long, 2–7 cm. wide, abundantly pulverulent scurvy-strigose, primary peduncle 8–15 cm. long, bracts broadly triangular to suborbicular, 10–15 mm. long, 5–7 mm. wide, glabrous. Flowers 20–25 mm. broad, buds to 9 mm. in diameter, pedicels 5–10 mm. long, bracteoles broadly triangular, to 10 mm. long; sepals 5, outer 2 trullate to oblong-ovate, subacute, 10–12 mm. long, 6–7 mm. wide, imbricate one suborbicular, rounded, 10–12 mm. long, 8–9 mm. wide, inner 2 suborbicular to orbicular-oblong, rounded, 10–14 mm. wide, all glabrous to medially sparingly strigillose without, completely glabrous within, marginally entire to apically ciliolate; petals 5, white, subquadrangular to spatulate, rounded, 15–19 mm. long, 9–11 mm. wide; stamens 25–35, filament 4–5 mm. long, anther 2.5–3 mm. long; ovary 5–7-locular, globose, 5–7-sulcate, glabrous, styles 5–7, to 7.5 mm. long, stigmas capitate. Berries 5–7-locular, globose, to 6 mm. in diameter (immature) 5–7-sulcate.

Distribution: Colombia (Departamento Caldas), mossy forest, alt. 3200–3400 m., flowering in September.

Specimens examined. Colombia, Caldas: Cordillera Occidental, Cerro Tatamá, *Pennell 10501* (NY).

3. *Saurauia Mexiae*⁶ Killip ex Soejarto sp. nov.

S. pseudostrigillosae Busc. affinis sed floribus grandiori-

⁶Killip annotated the collection (*Mexia* 8488) as *Saurauia Mexiae* Killip spec. nov., but so far as I am aware, the name and description of this concept have never been published.

bus, pedicellis longioribus, foliis subtus abundanter et molliter stellatis differt.—Holotypus: *Mexia* 8488 (US).

Trees to 10 m.; copiously pubescent. Branchlets somewhat terete, distinctly scarred, abundantly to sparingly pulverulent strigose. Leaves crowded near tip of branchlets; blades somewhat broadly ovate, abruptly acuminate with acumen to 15 mm. long, obtuse to rounded at base, rarely oblique, serrulate along margins, 17–28 cm. long, 9–15 cm. wide, chartaceous, in dry state dark dirty olive-brown above, grey-green beneath, somewhat scabrous above but somewhat soft beneath, secondary veins 16–22 pairs, tertiary veins elevated, more prominent than lesser venation, strigillose (trichomes with barbules) along veins with pustulate epidermis above, abundantly and softly stellate (trichomes very slender) along and between veins but mixed with unbranched multicellular trichomes along major veins with somewhat pustulate epidermis beneath; petioles 1.5–3 cm. long, 2–3 mm. in diameter, half-terete, densely pulverulent strigillose to strigose. Inflorescences crowded near tip of branchlets, straight, lax and somewhat spreading, ca. 100-flowered, 18–26 cm. long, 10–17 cm. wide, abundantly to densely pulverulent strigose to strigillose (trichomes with barbules), primary peduncle 8–11 cm. long, bracts triangular to linear, to 6 mm. long. Flowers 20–25 mm. broad, buds to 8 mm. in diameter, pedicels 5–12 mm. long, braeteoles minute, subulate, to 2 mm. long; sepals 5, orbicular, rarely oblong, rounded, rarely obtuse, 4–6 mm. long, 4–5 mm. wide, outer 2 abundantly pulverulent-stellate mixed with unbranched multicellular trichomes (with barbules), imbricate one abundantly pulverulent-stellate on outer half, densely pulverulent-stellate on inner half, inner 2 medially abundantly pulverulent-stellate, laterally sparingly pulverulent-stellate, all abundantly to densely appressed-stellate

on upper half, glabrous on lower half within, marginally and apically ciliolate to ciliate; petals 5, white, oblong to oblong-obovate, 9–11 mm. long, 5–7 mm. wide, stamens 100–200, filament 3.5–4.5 mm. long, anther 1.5 mm. long; ovary 5-locular, globose, 5-sulcate, glabrous, styles 5, 1 mm. long, stigmas simple. Berries not known.

Distribution: Ecuador (Provincia Esmeraldas), river bank, alt. 95 m., flowering in December.

Specimens examined. Ecuador, Esmeraldas; Parroquia de Concepción, below Playa Rica, *Mezía* 8488 (F, NY, S, U, UC, US-holotype).

4. **Saurauia chaparensis** Soejarto *sp. nov.*

Species foliis subtus abundanter stellatis, inflorescentiis laxis, floribus circiter 15 mm. latis, staminibus plus quam 100.—Holotypus: *Steinbach* 8920 (GH).

Shrubs?: copiously pubescent. Branchlets moderately stout, terete, prominently scarred, abundantly strigose often with barbate trichomes to glabrescent. Leaves crowded near tip of branchlets; blades obovate to oblong-obovate, blunt to very shortly acuminate at apex, cuneate at base, rarely oblique, serrulate with very fine serrulations along margins, 10–18 cm. long, 3–6 cm. wide, chartaceous, in dry state sooty above, olive-brown beneath, distinctly scabrous above and beneath, secondary veins 18–22 pairs, tertiary veins elevated, more prominent than lesser venation, sparingly clustered and strigillose along and between veins with pustulate epidermis above, abundantly stellate to rarely tufted along and between veins (often mixed with barbate trichomes along major veins) beneath, villous-barbate at axils of secondary veins beneath; petioles 2–3 cm. long, 1.5–2 mm. in diameter, terete to half-terete, abundantly tuberculate to strigillose with often barbate trichomes, scabrous.

Inflorescences crowded near tip of branchlets, straight, somewhat loose, 30-80-flowered, 12-20 cm. long, 5-12 cm. wide, densely pulverulent-tuberculate, primary peduncle 5-10 cm. long, bracts linear, to 6 mm. long, very rarely foliaceous, to 25 mm. long. Flowers ca. 15 mm. broad, buds to 6 mm. long, very rarely foliaceous, to 25 mm. long. Flowers ca. 15 mm. broad, buds to 6 mm. in diameter, pedicels 5-15(-20) mm. long, bracteoles triangular, to 2 mm. long; sepals 5, outer 2 oblong-obovate, acute, 3.5-4.5 mm. long, 3-3.5 mm. wide, densely strigillose (trichomes with barbules), imbricate one suborbicular, rounded, 4-5 mm. long, 3.5-4 mm. wide, densely strigillose on outer half (trichomes with barbules), completely glabrous on inner half, inner 2 suborbicular to orbicular-oblong, 4-5 mm. long, 3.5-4.5 mm. wide, medially densely strigillose (trichomes with barbules), laterally completely glabrous, all completely glabrous within, marginally subentire, apically irregularly ciliolate; petals 5, oblong to oblong-obovate, rounded to truncate and often incised, 7-9 mm. long, 5-7.5 mm. wide; stamens 100-150, filament 2-3 mm. long, anther 1-2 mm. long; ovary 5-7-locular, globose, 5-7-sulcate, glabrous, styles 5-7, obsolete to 4 mm. long, stigmas simple to capitate. Berries 5-7-locular, globose, to 5 mm. in diameter (immature), 5-7-sulcate.

Distribution: Bolivia (Departamento Cochabamba), forest, alt. 2200-2400 m., flowering in January and March.

Specimens examined. Bolivia, Cochabamba: Chapare, Incachaca, *Steinbach 8920* (F, GH-holotype, NY, S); *ibid.*, *Steinbach 9513* (F, G, GH, K, NY, S).

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NATURAL AND ARTIFICIAL HYBRID GENERIC NAMES OF ORCHIDS

SUPPLEMENT I : 1966-1969

BY

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SINCE the publication of the first compendium of "Natural and Artificial Hybrid Generic Names of Orchids, 1887-1965", in the Botanical Museum Leaflets, volume 21: 141-212, 1966, we have uncovered several previously unrecorded names in addition to those which have been published for the first time during the intervening period. These names, together with corrections and supplementary information, are included in this Supplement. Since hybrid generic names are not recorded in Index Kewensis, the first compendium and this supplement provide a similar tool for the interested orchidophiles. To increase its usefulness, each hybrid generic name is evaluated and treated in accordance with the rules set forth in both the International Code of Botanical Nomenclature and the International Code of Nomenclature for Cultivated Plants. Both of these codes derive their authority from the International Union of Biological Sciences.

In this Supplement, as in the first compendium, the rule of priority is strictly observed, an action most important if stabilization in orchid nomenclature is to be achieved. Along this line, we have noted the acceptance of some necessary changes by the Orchid Registration

Authority, Royal Horticultural Society, England, such as **Grammatocymbidium**, **Phalaerianda**, **Phragmipaphium**, **Recchara**, **Zygorhyncha** and **Zygostylis**, while to others, the rule of priority has yet to be applied. For example, in 1948, the hybrid generic name **Lyonara** was published with the parentage, *Trichoglottis* $\times$ *Vanda*. Since this constituted only a bigeneric hybrid, the use of the suffix -ara made the name illegitimate. Subsequently, this was corrected to **Trichovanda**. In 1959, **Lyonara** was published again with a trigeneric parentage, *Cattleya* $\times$ *Laelia* $\times$ *Schomburgkia*. This **Lyonara** is also illegitimate, since it represents a later homonym as well as a superfluous name. The correct name for this trigeneric hybrid is **Schombolaeliocattleya**, originally published by The Royal Horticultural Society in its Dictionary of Gardening, in 1951, thus antedating the later homonym. Nevertheless, we find that **Lyonara** of 1959, rather than **Schombolaeliocattleya** of 1951, is maintained in the current listings. Other discrepancies: the acceptance of **Rhynchovanda** (1958) rather than **Vandachostylis** (1935), the acceptance of **Brassophronitis** (1954) rather than **Sophrovola** (1895). The former hybrid name, involving *Rhynchostylis* and *Vanda*, is of special concern because **Vandachostylis** was fully described, illustrated in color, and also supplemented by anatomical descriptions and illustrations of the first hybrid, *V. Bernardii*. At the end of this same treatise, another hybrid generic name involving *Doritis* and *Phalaenopsis*, was mentioned, namely **Doritaenopsis**, but without any description or grex epithet. Notwithstanding the lack of description and a legitimate grex epithet, **Doritaenopsis** was and still is accepted by the Registration Authority, while **Vandachostylis** was and still is rejected in favor of a later illegitimate name.

In this Supplement, as in the original compendium,

there has been a strict adherence to the requirements of the Codes, especially Articles 40, H. 3 and H. 4 of the International Code of Botanical Nomenclature. The interpretation of these articles was clearly explained in the introduction to the first compendium, the correctness of which is confirmed by "An Annotated Glossary of Botanical Nomenclature", prepared on the authorization of the Nomenclature Section of the X. International Botanical Congress, in 1964. In this glossary on page 14, under the term "Formula", we find the following statement: "Condensed formulae formed from parts of generic names and applied to intergeneric hybrids are treated as 'generic names' (Arts. H. 3, H. 4) and are subject to the rule of priority and the homonym rule."

In a few cases, it was discovered that certain names had appeared in publications earlier than those which were cited in the original list. These corrections are included in this Supplement in Part I, and, as indicated, they replace the earlier entries. The citation of place of publication for the following names have been corrected: **Grammatocymbidium**, **Gymnaplatanthera**, **Spathophaius**, **Symphodontioda**, **Symphodontoglossum**, **Symphyglossonia** and **Zygostylis**.

Hybrids reported for the first time for previously published hybrid generic names include, **Grammatocymbidium**, **Renaglottis** and **Renancentrum**.

Finally, attention is called to the arrangement of parent genera in Part II of this Supplement. The generic names involved in the makeup of a given hybrid genus appear in alphabetical sequence only once under each name.

PART I

List of hybrid generic names

Aeridocentrum in Orch. Rev. 75: February, 1967

Aerides × *Ascocentrum*

1st hybr.: *A.* Luke Nok

Parentage: *Aerides flabellatum* × *Ascocentrum curvifolium*

Ansidium in Orch. Rev. 74: May, 1966

Ansellia × *Cymbidium*

1st hybr.: *A.* Bess Waldon

Parentage: *Ansellia africana* × *Cymbidium* Dunster Castle

Arachnostylis in Orch. Rev. 74: April, 1966

Arachnis × *Rhynchostylis*

1st hybr.: *A.* Chorchalood

Parentage: *Arachnis Hookeriana* × *Rhynchostylis gigantea*

Asconopsis in Orch. Rev. 76: February, 1968

Ascocentrum × *Phalaenopsis*

1st hybr.: *A.* Mini-Coral

Parentage: *Phalaenopsis Schilleriana* × *Ascocentrum miniatum*

Ascorachnis in Orch. Rev. 75: August, 1967

Arachnis × *Ascocentrum*

1st hybr.: *A.* George Neo

Parentage: *Arachnis Ishbel* × *Ascocentrum miniatum*

Ascovandoritis in Orch. Rev. 77: September, 1969

Ascocentrum × *Doritis* × *Vanda*

1st hybr.: *A.* Sonnhild Kitts

Parentage: *Doritis pulcherrima* × *Ascocenda* Red Gem

Barlacieras in Riviera Scientif. 11: 62, 1924

Observation: Add Syn.: **Barliacieras** in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 167, 1950.

Barliacieras in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 167, 1950

Observation: See **Barlacieras**.

Bateostylis in Orch. Rev. 75: November, 1967

Batemannia × *Otostylis*

1st hybr.: *B.* Silver Star

Parentage: *Batemannia Colleyi* × *Otostylis brachystalix*

Bifrinlaria in Lager and Hurrell Seedling Listing no. 866-S: p. 1,
September, 1966.

Bifrenaria × *Maxillaria*

1st hybr.: unnamed

Parentage: *Maxillaria Sanderiana* × *Bifrenaria Harrisoniae*

Bloomara in Orch. Rev. 74: June, 1966

Broughtonia × *Laeliopsis* × *Tetramicra*

1st hybr.: B. Jim

Parentage: *Tetramicra canaliculata* × *Broughtopsis* Kingston (as **Lio-
ponia** Kingston)

Burkillara in Orch. Rev. 75: December, 1967

Aerides × *Arachnis* × *Vanda*

1st hybr.: B. Margaret Ede

Parentage: **Aeridachnis** Bogor × *Vanda Cooperi* (in Orch. Rev. 76:
June, 1968)

Observation: For the hybrid **Burkillara** Henry see **Wrefordara**.

Carterara in Orch. Rev. 77: January, 1969

Aerides × *Renanthera* × *Vandopsis*

1st hybr.: C. Evening Glow

Parentage: **Renanopsis** Lena Rowold × *Aerides Lawrenceae*

Catamodes in Orch. Rev. 75: 205, 1967

Catasetum × *Mormodes*

1st hybr.: C. Brown Derby

Parentage: *Catasetum Warscewiczii* × *Mormodes atropurpurea*

Catanoches in Orch. Rev. 75: 205, 1967

Catasetum × *Cycnoches*

1st hybr.: C. Green Beret

Parentage: *Catasetum Warscewiczii* × *Cycnoches ventricosum*

Cattleyopsisgoa in Orch. Rev. 75: November, 1967

Cattleyopsis × *Domingoa*

1st hybr.: C. Little Fellow

Parentage: *Domingoa hymenodes* × *Cattleyopsis Ortgiesiana*

Cattleyopsistonia in Orch. Rev. 74: July, 1966

Broughtonia × *Cattleyopsis*

1st hybr.: C. Leona

Parentage: *Cattleyopsis Ortgiesiana* × *Broughtonia sanguinea*

Cephalophrys in Orchid World 2: 114, 1912

Cephalanthera × *Ophrys*

1st. hybr.: *C. integra*

Parentage: *Ophrys apifera* × *Cephalanthera rubra*

Christieara in Orch. Rev. 77: November, 1969

Aerides × *Ascocentrum* × *Vanda*

1st hybr.: not yet reported

Observation: For the hybrid **Christieara** Mem. Lillian Arnold see **Reinikkaara**.

Cochlenia in Orch. Rev. 75: November, 1967

Cochleanthes × *Stenia*

1st hybr.: *C. Bryn Mawr*

Parentage: *Stenia pallida* × *Cochleanthes discolor*

Coeloplatanthera in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 169, 1950

Coeloglossum × *Platanthera*

1st hybr.: *C. Brueggeri*

Parentage: *Coeloglossum viride* × *Platanthera chlorantha*

Cymbiphyllum in Orch. Rev. 75: March, 1967

Observation: See **Grammatocymbidium**.

Dactylanthera in Willis, Dict. Fl. Plants and Ferns ed. 7; 327, 1966

Observation: See **Rhizanthera**.

Dactyleucorchis in Ann. Univ. Eötvös, Budapest 8: 319, 1966

Dactylorhiza × *Leucorchis*

1st hybr.: *D. Bruniana* (as *Orchis Bruniana*)

Parentage: *Leucorchis albida* × *Dactylorhiza maculata*

Dactylella in Ann. Univ. Eötvös, Budapest 8: 318, 1966

Observation: See **Dactylitella**.

Dactylitella in Watsonia 6: 132, 1965

Observation: Add Syn.: **Dactylella** in Ann. Univ. Eötvös, Budapest 8: 318, 1966

Dactyloceras nom. hybr. gen. nov.

Aceras × *Dactylorhiza*

1st hybr.: *D. helvetica* comb. nov. (Basionym: **Orchiaceras helvetica** Cif. & Giac., Nomencl. Fl. Ital. pt. 1: 167, 1950)

Parentage: *Aceras anthropophora* × *Dactylorhiza latifolia*

Dactylodenia in Bot. Mus. Leaf. Harvard Univ. 21: 157, 1966

Dactylorhiza × *Gymnadenia*

1st hybr.: *D. Heinzeliana* comb. nov. (Basionym: *Orchis Heinzeliana* Reich. in Verh. K.K. zool. bot. Ges. 26: 464, 1876)

Parentage: *Dactylorhiza maculata* × *Gymnadenia conopea*

Syn.: **Dactylogymnadenia** in Ann. Univ. Eötvös, Budapest 8: 318,
1966

Dactylogymnadenia in Ann. Univ. Eötvös, Budapest 8: 318, 1966

Observation: See **Dactylodenia**.

Degarmoara in Orch. Rev. 76: February, 1968

Brassia × *Miltonia* × *Odontoglossum*

1st hybr.: *D. Agnes*

Parentage: **Odontonia** Debutante × *Brassia antherotes*

DeWolfara nom. hybr. gen. nov.

Renanthera × *Ascoglossum* × *Ascocentrum* × *Euanthe* × *Vanda*

1st hybr.: *D. Cassino* (as **Shigeuraara** Cassino)

Parentage: **Renanthoglossum** Red Delight × **Schlechterara** Meda
Arnold

Dialaeliopsis in Orch. Rev. 74: November, 1966

Diacrium × *Laeliopsis*

1st hybr.: *D. Tobago*

Parentage: *Diacrium bicornutum* × *Laeliopsis domingensis*

Dillonara in Orch. Rev. 74: December, 1966

Epidendrum × *Laelia* × *Schomburgkia*

1st. hybr.: *D. Bronze Kahili*

Parentage: **Schombolaelia** Maunalani × *Epidendrum diurnum*

Doricentrum in Orch. Rev. 77: October, 1969

Doritis × *Ascocentrum*

1st. hybr.: *D. Merrilee Wallbrunn*

Parentage: *Doritis pulcherrima* × *Ascocentrum curvifolium*

Doriella in Orch. Rev. 74: May, 1966

Doritis × *Kingiella*

1st hybr.: *D. Tiny*

Parentage: *Doritis pulcherrima* × *Kingiella philippinensis*

Doriellaopsis in Orch. Rev. 76: December, 1968

Doritis × *Kingiella* × *Phalaenopsis*

1st hybr.: *D. Burma*

Parentage: **Doritaeniopsis** Purple Gem × *Kingiella taenialis*

Encyclipedium Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Encyclia × *Cypripedium*

1st hybr.: not yet reported

Ernestara in Orch. Rev. 76: December, 1968

Phalaenopsis × *Renanthera* × *Vandopsis*

1st hybr.: *E. Helga* Reuter

Parentage: **Renanopsis** Cape Sable × *Phalaenopsis* Dos Pueblos

Garayara in Amer. Orch. Soc. Bull. 38: 676, 1969

Arachnis × *Paraphalaenopsis* × *Vandopsis*

1st hybr.: G. Lee Kim Hong (as **Laycockara** Lee Kim Hong)

Parentage: **Pararachnis** Lee Siew Chin × *Vandopsis lissochiloides*

Gauntlettara in Orch. Rev. 74: April, 1966

Broughtonia × *Cattleyopsis* × *Laeliopsis*

1st hybr.: G. Noel

Parentage: *Cattleyopsis Ortgiesiana* × **Broughtopsis** Kingston (as **Lioponia** Kingston)

Giddingsara in Amer. Orch. Soc. Bull. 38: 676, 1969

Ascocentrum × *Euanthe* × *Renanthera* × *Vanda* × *Vandopsis*

1st hybr.: G. Sapphire (as **Onoara** Sapphire)

Parentage: **Schlechterara** Meda Arnold × **Renanopsis** Lena Rowold

Gilmourara nom. hybr. gen. nov.

Aerides × *Arachnis* × *Ascocentrum* × *Euanthe* × *Vanda*

1st hybr.: G. Gracia (as **Lewisara** Gracia)

Parentage: **Aeridachnis** Bogor × **Schlechterara** Ophelia

Grammatocymbidium in Orch. Rev. 30: 338, 1922

Cymbidium × *Grammatophyllum*

1st hybr.: G. Emil Anderson (as **Cymbiphyllum** Emil Anderson)

Parentage: *Cymbidium pendulum* × *Grammatophyllum Measuresianum*

Observation: This replaces the earlier entry.

Syn.: **Cymbiphyllum** in Orch. Rev. 75: March, 1967

Greatwoodara nom. hybr. gen. nov.

Ascocentrum × *Euanthe* × *Renanthera* × *Vanda*

1st hybr.: G. William Doi (as **Kagawara** William Doi)

Parentage: *Renanthera* Kilauea × **Schlechterara** Meda Arnold

Gymleucorchis in Lond. Cat. Brit. Pl., ed. 11; 43, 1925

Gymnadenia × *Leucorchis*

1st hybr.: G. *Schweinfurthii* (as *Gymnadenia Schweinfurthii*, 1865)

Parentage: *Gymnadenia conopea* × *Leucorchis albida*

Ill.: in Verh. Zool.-Bot. Gesellsch. Wien 15: t. 5, f. 15-16, 1865

Observation: This replaces the earlier entry of **Gymnorchis**.

Syn.: **Gymnabicchia** in Camus, Monogr. Orch. Europ. 315, 1908

Leucadenia in Fedde Rep. 16: 290, 1920, not **Leucadenia** Klotzsch, 1864

Gymnorchis in Dostál, Fl. Czechosl. (Kvetena CSR) ed. 2, 2101, 1950

Gymnabicchia in Camus, Monogr. Orch. Europ. 315, 1908

Observation: See **Gymleucorchis**. This replaces the earlier entry.

Gymnorchis in Dostál, Fl. Czechosl. (Kvetena CSR) ed. 2, 2101, 1950

Observation: See **Gymleucorchis**. This replaces the earlier entry.

Gymnotraunsteinera in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 171, 1950

Gymnadenia × *Traunsteinera*

1st hybr.: *G. Vallesiaca* (as *Orchis Vallesiaca*)

Parentage: *Gymnadenia conopea* × *Traunsteinera globosa*

Gymnaplatanthera in Lambert, Notes Orch. Hybr. 9, 1907

Gymnadenia × *Platanthera*

1st hybr.: *G. Chodati* (as *Gymnadenia Chodati*)

Parentage: *Gymnadenia conopea* × *Platanthera bifolia*

Ill.: in Fedde Rep. Sonderbeih. A. 5: t. 434, f. 1, 1939

Observation: This replaces the earlier entry of **Gymnplatanthera**.

Syn.: **Gymnplatanthera** in Camus, Monogr. Orch. Europ. 337, 1908

Gymplatanthera in Winchester Coll. N.H. Rep. 33, 1911

Gymnplatanthera in Camus, Monogr. Orch. Europ. 337, 1908

Observation: See **Gymnaplatanthera**. This replaces the earlier entry.

Gymplatanthera in Winchester Coll. N.H. Rep. 33, 1911

Observation: See **Gymnaplatanthera**.

Hawkesara in Orch. Rev. 76: November, 1968

Cattleya × *Cattleyopsis* × *Epidendrum*

1st hybr.: *H. Alex*

Parentage: **Epicattleya** Frances Dyer × *Cattleyopsis Ortgiesiana*

Herbertara in Orch. Rev. 76: December, 1968

Cattleya × *Laelia* × *Schomburgkia* × *Sophronitis*

1st hybr.: *H. Thelma*

Parentage: **Schombocattleya** Harry Dunn × **Sophrolaeliocattleya** *Radians*

Hermibicchia in Camus, Monogr. Orch. Europ. 312, 1908

Observation: See **Herminorchis**. This replaces the earlier entry.

Hermileucorchis in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 169, 1950

Observation: See **Herminorchis**.

Herminorchis in Fourn., Quatre Fl. Fr. 201, 1935

Herminium × *Leucorchis*

1st hybr.: *H. Aschersoniana* (as *Gymnadenia Aschersoniana*, 1888)

Parentage: *Leucorchis albida* × *Herminium monorchis*

Observation: This replaces the earlier entry of **Leucermidium** and **Herminiorchis**.

Syn.: **Hermibicchia** in Camus, Monogr. Orch. Europ. 312, 1908

Leucermidium in Gartenfl. 85: 253, 1936

Hermileucorchis in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 169, 1950

Huntara nom. hybr. gen. nov.

Arachnis × *Euanthe* × *Renanthera* × *Vanda* × *Vandopsis*

1st hybr.: *H. Teoh Cheng Swee* (as **Teohara** Teoh Cheng Swee)

Parentage: **Arandanthe** Kian Kee × **Renanopsis** Lena Rowold

Huntleanthes in Orch. Rev. 74: January, 1966

Cochleanthes × *Huntleya*

1st hybr.: *H. Narberth*

Parentage: *Cochleanthes discolor* × *Huntleya Burtii* (*meleagris*)

Ionettia in Orch. Rev. 76: May, 1968

Comparettia × *Ionopsis*

1st hybr.: *I. Rose Petal*

Parentage: *Comparettia falcata* × *Ionopsis paniculata*

Ioncidium in Orch. Rev. 76: December, 1968

Observation: See **Ionocidium** including the hybrid, **Ioncidium** Little Bit.

Ionocidium in Orch. Rev. 76: May, 1968

Ionopsis × *Oncidium*

1st hybr.: *I. Ressie Toy*

Parentage: *Ionopsis paniculata* × *Oncidium pulchellum*

Syn.: **Ioncidium** in Orch. Rev. 76: December, 1968

Jacquinparis Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Jacquinella × *Liparis*

1st hybr.: not yet reported

Kagawara in Orch. Rev. 76: June, 1968

Ascocentrum × *Renanthera* × *Vanda*

1st hybr.: *K. Firebird* (Orch. Rev. 77: March, 1969)

Parentage: *Renanthera Storiei* × *Ascocenda* Red Gem

Observation: for the hybrid **Kagawara** William Doi see **Greatwood-ara**.

Kamemotoara nom. hybr. gen. nov.

Aerides × *Euanthe* × *Rhynchostylis* × *Vanda*

1st hybr.: *K. Porchina* Blue (as **Perreiraara** Porchina Blue)

Parentage: **Rhynhovandante** Blue Angel × *Aerides mitrata*

Laeliocatonia in Orch. Rev. 75: March, 1967

Broughtonia × *Cattleya* × *Laelia*

1st hybr.: *L. Betty* Holley

Parentage: **Laeliocattleya** Bright Night × *Broughtonia sanguinea*

Laeliopleya in Orch. Rev. 74: March, 1966

Cattleya × *Laeliopsis*

1st hybr.: *L. Orange* Glow

Parentage: *Cattleya aurantiaca* × *Laeliopsis domingensis*

Laycockara in Orch. Rev. 74: August, 1966

Arachnis × *Phalaenopsis* × *Vandopsis*

1st hybr.: not yet reported

Observation: For the hybrids **Laycockara** Lee Kim Hong and L. Ian Trevor, see **Garayara**.

Leucadenia in Fedde Rep. 16: 290, 1920

Observation: Not **Leucadenia** Klotzsch, 1864. See **Gymleucorchis**.
This replaces the earlier entry.

Leucermidium in Gartenfl. 85: 253, 1936

Observation: See **Herminorchis**. This replaces the earlier entry.

Leucororchis in Ciferri and Giacomini, Nomencl. Fl. Ital. pt. 1: 170, 1950

Leucorchis × *Orchis*

1st hybr.: not yet reported

Observation: For the hybrids **Leucorochis** *Bruniana* and *L. albucina* see **Dactyleucorchis**.

Lewisara in Orch. Rev. 76: February, 1968

Aerides × *Arachnis* × *Ascocentrum* × *Vanda*

1st hybr.: *L. Max*

Parentage: **Aeridachnis** Bogor × **Ascocenda** Charm

Observation: For the hybrid **Lewisara** Gracia see **Gilmourara**.

Loroglorchis in Journ. Bot. Fr. 6: 110, 1892

Observation: This replaces the earlier entry. See **Orchimantoglossum**.

Lymanara in Orch. Rev. 75: August, 1967

Aerides × *Arachnis* × *Renanthera*

1st hybr.: L. Mary Ann

Parentage: *Aeridachnis* Bogor × *Renanthera Storiei*

Macradesa in Orch. Rev. 76: December, 1968

Gomesa × *Macradenia*

1st hybr.: M. Brown Baby

Parentage: *Gomesa recurva* × *Macradenia brassavolae*

Maxillacaste in La Sem. Hortic. I: 350, 1897

Maxillaria × *Lycaste*

1st hybr.: not yet reported

Mizutara in Orch. Rev. 74: August, 1966

Cattleya × *Diacrium* × *Schomburgkia*

1st hybr.: M. Pink Kahili

Parentage: *Schombocattleya* Diamond Head × *Diacrium bicornutum*

Mokara in Orch. Rev. 77: December, 1969

Arachnis × *Ascocentrum* × *Vanda*

1st hybr.: M. Wai Liang

Parentage; *Arachnis* Ishbel × *Ascocenda* Red Gem

Moscosoara in Orch. Rev. 77: September, 1969

Broughtonia × *Epidendrum* × *Laeliopsis*

1st hybr.: M. Santo Domingo

Parentage: *Broughtopsis* Kingston × *Epidendrum olivaceum*

Myrmecocattleya in Orch. Rev. 28: 50, 1920

Observation: See *Schombocattleya*.

Myrmecolaelia in Orch. Rev. 28: 50, 1920

Observation: See *Schombolaelia*.

Nobleara in Orch. Rev. 77: September, 1969

Aerides × *Renanthera* × *Vanda*

1st hybr.: N. Royal Monarch

Parentage: *Renantanda* Jukichi Murata × *Aerides odorata*

Oncidenia in Orch. Rev. 74: February, 1966

Macradenia × *Oncidium*

1st hybr.: O. Helen

Parentage: *Oncidium* Helen Brown × *Macradenia brassavolae*

Oncidpilia in Orch. Rev. 74: February, 1966

Oncidium × *Trichopilia*

1st hybr.: O. Don Carlos

Parentage: *Oncidium Papilio* × *Trichopilia coccinea*

Onoara in Orch. Rev. 75: August, 1967

Ascocentrum × *Renanthera* × *Vanda* × *Vandopsis*

1st hybr.: not yet reported

Observation: For the hybrid **Onoara Sapphire** see **Giddingsara**.

Orchidatyla in Watsonia 6: 133, 1965

Observation: Syn.: **Orchidactylorhiza** in Ann. Univ. Eötvös, Budapest 8: 315, 1966

Orchidactylorhiza in Ann. Univ. Eötvös, Budapest 8: 315, 1966

Observation: See **Orchidactyla**.

Orchimantoglossum in Aschers. & Graebn., Syn. 3: 799, 1907

Orchis × *Himantoglossum*

1st hybr.: *O. Lacasei*

Parentage: *Orchis simia* × *Himantoglossum hircinium*

Observation: Because *Himantoglossum* is conserved over *Loroglossum* this replaces the earlier entry.

Syn.: **Loroglorchis** in Journ. Bot. Fr. 6: 110, 1893

Osmentara in Orch. Rev. 74: June, 1966

Broughtonia × *Cattleya* × *Laeliopsis*

1st hybr.: *O. Bill*

Parentage: *Cattleya* R. Prowe × *Broughtopsis* Kingston (as **Lioponia** Kingston)

Otonisia in Orch. Rev. 77: January, 1969

Aganisia × *Otostylis*

1st hybr.: *O. Broadway*

Parentage: *Otostylis brachystalix* × *Aganisia pulchella*

Pattoniheadia Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Pattonia × *Bromheadia*

1st hybr.: not yet reported

Perreiraara in Orch. Rev. 77: September, 1969

Aerides × *Rhynchosstylis* × *Vanda*

1st hybr.: not yet reported

Observation: For the hybrid **Perreiraara Porchina Blue** see **Kame-motoara**.

Pterocottia Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Pterostylis × *Prescottia*

1st hybr.: not yet reported

Reinikkaara nom. hybr. gen. nov.

Aerides × *Ascocentrum* × *Euanthe* × *Vanda*

1st hybr.: *R.* Mem. Lillian Arnold (as **Christieara** Mem. Lillian Arnold)

Parentage: *Aerides Lawrenceae* × *Schlechterara* Meda Arnold

Renaglottis in Bull. Pac. Orch. Soc. Hawaii 14: 85, 1957

Renanthera × *Trichoglottis*

1st hybr.: *R.* Lone Warrior (in Orch. Rev. 74: November, 1966)

Parentage: *Renanthera Storiei* × *Trichoglottis fasciata*

Renancentrum in Orch. Rev. 70: September, 1962

Ascocentrum × *Renanthera*

1st hybr.: *R.* Yap Sin Yee (in Orch. Rev. 73: May, 1965)

Parentage: *Ascocentrum curvifolium* × *Renanthera* Brookie Chandler

Observation: For the hybrid **Renancentrum** *Curvionica* see **Ascorella**.

Renanthoceras nom. hybr. gen. nov.

Pteroceras × *Renanthera*

1st hybr.: *R.* Kona (as **Sarcothera** Kona)

Parentage: *Pteroceras pallidus* × *Renanthera monachica*

Renanthopsis in Bull. Soc. Hort. Fr. ser. 5, 4: 342, 1931

Observation: This replaces the earlier entry.

Restesia Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Restrepia × *Orleanesia*

1st hybr.: not yet reported

Rhizanthera in Watsonia 6: 133, 1965

Observation: Add Syn.: **Dactylanthera** in Willis, Dict. Fl. Plants and Ferns, ed. 7: 327, 1966

Rhyndoropsis in Orch. Rev. 74: October, 1966

Doritis × *Phalaenopsis* × *Rhynchostylis*

1st hybr.: *R.* Florida

Parentage: **Doritaenopsis** Dorette × *Rhynchostylis retusa*

Rodrenia in Amer. Orch. Soc. Bull. 31: 357, 1962

Observation: See **Rodridenia**.

Rodridenia in Orch. Rev. 70: April, 1962

Observation: Add Syn.: **Rodrenia** in Amer. Orch. Soc. Bull. 31: 357, 1962

Rodriopsis in Orch. Rev. 77: September, 1969

Rodriguezia × *Ionopsis*

1st hybr.: *R.* Edwardine Klemm

Parentage: *Rodriguezia secunda* × *Ionopsis paniculata*

Rumrillara in Orch. Rev. 77: September, 1969

Ascocentrum × *Neofinetia* × *Rhynchostylis*

1st hybr.: *R. Rosyleen*

Parentage: **Rhynchocentrum** Lilac Blossom × **Ascofinetia** Peaches

Sarcorhiza in Orch. Rev. 74: January, 1966

Rhinerrhiza × *Sarcochilus*

1st hybr.: *S. Doroty*

Parentage: *Sarcochilus Hartmanii* × *Rhinerrhiza divitiflora*

Sarcothera in Orch. Rev. 62: 92, 1954

Renanthera × *Sarcochilus*

1st hybr.: not yet reported

Observation: For the hybrid **Sarcothera** Kona see **Renanthoceras**.

This replaces the earlier entry.

Schombocattleya in Orch. Rev. 13: 245, 1905

Observation: Add Syn.: **Schomocattleya** in Orch. Rev. 28: 50, 1920

Myrmecocattleya in Orch. Rev. 28: 50, 1920

Schombolaelia in Orch. Rev. 21: 254, 1913

Observation: Add Syn.: **Myrmecolaelia** in Orch. Rev. 28: 50, 1920

Schombonitis in Orch. Rev. 28: 50, 1920

Schomburgkia × *Sophronitis*

1st hybr.: *S. Stella*

Parentage: *Schomburgkia superbiens* × *Sophronitis grandiflora*

Schomocattleya in Orch. Rev. 28: 50, 1920

Observation: See **Schombocattleya**.

Selenipanthes Dillon in Amer. Orch. Soc. Bull. 38: 676, 1969

Selenipedium × *Lepanthes*

1st hybr.: not yet reported

Serapirhiza in Jahresb. Naturwiss. Ver. Wuppertal, Heft 21/22:
103, 1968

Serapias × *Dactylorhiza*

1st hybr.: *S. Sambucino-lingua* (Barla) comb. nov.

(Basionym: *Orchis sambucina* var. *sambucino-lingua* Barla, Icon.
Orch. 60, 1868)

Parentage: *Serapias Lingua* × *Dactylorhiza sambucina*

Shigeuraara in Orch. Rev. 77: November, 1969

Renanthera × *Ascoglossum* × *Ascocentrum* × *Vanda*

1st hybr.: not yet reported

Observation: For the hybrid **Shigeuraara** Cassino see **DeWolfara**.

Spathophaius in Orchid Weekly 1: 268, 1959

Observation: This replaces the earlier entry.

Stanfieldara in Orch. Rev. 77: November, 1969

Sophronitis × *Laelia* × *Epidendrum*

1st hybr.: S. Will Bates

Parentage: **Sophrolaelia** Psyche × *Epidendrum vitellinum*

Sweetara in Amer. Orch. Soc. Bull. 38: 676, 1969

Paraphalaenopsis × *Rhynchostylis* × *Vanda*

1st hybr.: S. Oi Yee (as **Yapara** Oi Yee)

Parentage: **Paravanda** Suavei × **Vandachostylis** Tan Geat Leng (as **Rhynchovanda** Tan Geat Leng)

Symphodontioda in Orchid Weekly 4: 121, 1963

Observation: This replaces the earlier entry.

Symphodontoglossum in Orchid Weekly 4: 121, 1963

Observation: This replaces the earlier entry.

Symphyglossonia in Orchid Weekly 4: 121, 1963

Observation: This replaces the earlier entry.

Teohara in Orch. Rev. 76: February, 1968

Arachnis × *Renanthera* × *Vanda* × *Vandopsis*

1st hybr.: not yet reported

Observation: For the hybrid **Teohara** Teo Cheng Swee see **Huntara**

Vanglossum in Orch. Rev. 77: March, 1969

Ascoglossum × *Vanda*

1st hybr.: *V.* Oriental Jewel

Parentage: *Vanda Merrillii* × *Ascoglossum calopterum*

Withnerara in Orch. Rev. 74: November, 1966

Aspasia × *Miltonia* × *Odontoglossum* × *Oncidium*

1st hybr.: *W.* Moon Glow

Parentage: **Oncidasia** Starlight × **Odontonia** Wonder

Wrefordara in Amer. Orch. Soc. Bull. 38: 676, 1969

Aerides × *Arachnis* × *Euanthe* × *Vanda*

1st hybr.: *W.* Henry (as **Burkillara** Henry)

Parentage: **Aeridachnis** Bogor × **Vandanthe** Ellen Noa

Yapara in Orch. Rev. 74: November, 1966

Phalaenopsis × *Rhynchostylis* × *Vanda*

1st hybr.: not yet reported

Observation: For the hybrid **Yapara** Oi Yee see **Sweetara**.

Zygomena in Die Natuerl. Pflanzenfam. Erg.-heft II, 92, 1908

Zygopetalum × *Zygosepalum* (*Menadenium*)

1st hybr.: *Z. Roeblingiana* (as *Zygopetalum Roeblingianum*)

Parentage: *Zygopetalum maxillare* × *Zygosepalum labiosum*

Ill.: in Gard. Chron. ser. 3, 34: 227, f. 93, 1903

Observation: This replaces the former entry.

Zygostylis in Handbook Orch. Nomencl. and Reg., p. 47, 1965

Observation: See Orch. Rev. 74: April, 1966. This replaces the earlier entry.

PART II

Parentage index to hybrid generic names

<i>Parent genera</i>	<i>Hybrid genus</i>
<i>Aceras</i> × <i>Dactylorhiza</i>	= <i>Dactyloceras</i>
<i>Aerides</i> × <i>Arachnis</i> × <i>Ascocentrum</i> × <i>Euanthe</i> × <i>Vanda</i>	= <i>Gilmourara</i>
<i>Aerides</i> × <i>Arachnis</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Lewisara</i>
<i>Aerides</i> × <i>Arachnis</i> × <i>Euanthes</i> × <i>Vanda</i>	= <i>Wrefordara</i>
<i>Aerides</i> × <i>Arachnis</i> × <i>Renanthera</i>	= <i>Lymanara</i>
<i>Aerides</i> × <i>Arachnis</i> × <i>Vanda</i>	= <i>Burkillara</i>
<i>Aerides</i> × <i>Ascocentrum</i>	= <i>Aeridocentrum</i>
<i>Aerides</i> × <i>Ascocentrum</i> × <i>Euanthe</i> × <i>Vanda</i>	= <i>Reinikkaara</i>
<i>Aerides</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Christieara</i>
<i>Aerides</i> × <i>Euanthe</i> × <i>Rhynchosstylis</i> × <i>Vanda</i>	= <i>Kamemotoara</i>
<i>Aerides</i> × <i>Renanthera</i> × <i>Vanda</i>	= <i>Nobleara</i>
<i>Aerides</i> × <i>Renanthera</i> × <i>Vandopsis</i>	= <i>Carterara</i>
<i>Aerides</i> × <i>Rhynchosstylis</i> × <i>Vanda</i>	= <i>Perreiraara</i>
<i>Aganisia</i> × <i>Otostylis</i>	= <i>Otonisia</i>
<i>Ansellia</i> × <i>Cymbidium</i>	= <i>Ansidium</i>
<i>Arachnis</i> × <i>Aerides</i> × <i>Ascocentrum</i> × <i>Euanthe</i> × <i>Vanda</i>	= <i>Gilmourara</i>
<i>Arachnis</i> × <i>Aerides</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Lewisara</i>
<i>Arachnis</i> × <i>Aerides</i> × <i>Euanthe</i> × <i>Vanda</i>	= <i>Wrefordara</i>
<i>Arachnis</i> × <i>Aerides</i> × <i>Renanthera</i>	= <i>Lymanara</i>
<i>Arachnis</i> × <i>Aerides</i> × <i>Vanda</i>	= <i>Burkillara</i>
<i>Arachnis</i> × <i>Ascocentrum</i>	= <i>Ascorachnis</i>
<i>Arachnis</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Mokara</i>

Arachnis × Euanthe × Renanthera × Vanda × Vandopsis	= Huntara
Arachnis × Paraphalaenopsis × Vandopsis	= Garayara
Arachnis × Phalaenopsis × Vandopsis	= Laycockara
Arachnis × Renanthera × Vanda × Vandopsis	= Teohara
Arachnis × Rhynchostylis	= Arachnostylis
Ascocentrum × Aerides	= Aeridocentrum
Ascocentrum × Aerides × Arachnis × Euanthe × Vanda	= Gilmourara
Ascocentrum × Aerides × Arachnis × Vanda	= Lewisara
Ascocentrum × Aerides × Euanthe × Vanda	= Reinikkaara
Ascocentrum × Aerides × Vanda	= Christieara
Ascocentrum × Arachnis	= Ascorachnis
Ascocentrum × Arachnis × Vanda	= Mokara
Ascocentrum × Ascoglossum × Euanthe × Renan- thera × Vanda	= DeWolfara
Ascocentrum × Ascoglossum × Renanthera × Vanda	= Shigeuraara
Ascocentrum × Doritis	= Doricentrum
Ascocentrum × Doritis × Vanda	= Ascovandoritis
Ascocentrum × Euanthes × Renanthera × Vanda	= Greatwoodara
Ascocentrum × Euanthe × Renanthera × Vanda × Vandopsis	= Giddingsara
Ascocentrum × Neofinetia × Rhynchostylis	= Rumrillara
Ascocentrum × Phalaenopsis	= Asconopsis
Ascocentrum × Renanthera	= Renancentrum
Ascocentrum × Renanthera × Vanda	= Kagawara
Ascocentrum × Renanthera × Vanda × Vandopsis	= Onoara
Ascoglossum × Ascocentrum × Renanthera × Vanda	= DeWolfara
Ascoglossum × Vanda	= Vanglossum
Ascoglossum × Ascocentrum × Renanthera × Vanda	= Shigeuraara
Aspasia × Miltonia × Odontoglossum × Oncidium	= Withnerara
Batemannia × Otostylis	= Bateostylis
Bifrenaria × Maxillaria	= Bifrinlaria
Brassia × Miltonia × Odontoglossum	= Degarmoara
Bromheadia × Pattonia	= Pattoniheadia
Broughtonia × Cattleya × Laelia	= Laeliocatonia
Broughtonia × Cattleya × Laeliopsis	= Osmentara

Broughtonia × Cattleyopsis	= Cattleyopsistonia
Broughtonia × Cattleyopsis × Laeliopsis	= Gauntlettara
Broughtonia × Epidendrum × Laeliopsis	= Moscosoara
Broughtonia × Laeliopsis × Tetramicra	= Bloomara
Catasetum × Cynoches	= Catanoches
Catasetum × Mormodes	= Catamodes
Cattleya × Broughtonia × Laelia	= Laeliocatonia
Cattleya × Broughtonia × Laeliopsis	= Osmentara
Cattleya × Cattleyopsis × Epidendrum	= Hawkesara
Cattleya × Diacrium × Schomburgkia	= Mizutara
Cattleya × Laelia × Schomburgkia × Sophronitis	= Herbertara
Cattleya × Laeliopsis	= Laeliopleya
Cattleyopsis × Broughtonia	= Cattleyopsistonia
Cattleyopsis × Broughtonia × Laeliopsis	= Gauntlettara
Cattleyopsis × Cattleya × Epidendrum	= Hawkesara
Cattleyopsis × Domingoa	= Cattleyopsisgoa
Cephalanthera × Ophrys	= Cephalophrys
Cochleanthes × Huntleya	= Huntleanthes
Cochleanthes × Stenia	= Cochlenia
Coeloglossum × Platanthera	= Coeloplatanthera
Comparettia × Ionopsis	= Ionettia
Cynoches × Catasetum	= Catanoches
Cymbidium × Ansellia	= Ansidium
Cypripedium × Encyclia	= Encyclipedium
Dactylorhiza × Aceras	= Dactyloceras
Dactylorhiza × Leucorchis	= Dactyleucorchis
Dactylorhiza × Serapias	= Serapirhiza
Diacrium × Cattleya × Schomburgkia	= Mizutara
Diacrium × Laeliopsis	= Dialaeliopsis
Domingoa × Cattleyopsis	= Cattleyopsisgoa
Doritis × Ascocentrum	= Doricentrum
Doritis × Ascocentrum × Vanda	= Ascovandoritis
Doritis × Kingiella	= Doriella
Doritis × Kingiella × Phalaenopsis	= Doriellaopsis
Doritis × Phalaenopsis × Rhynchostylis	= Rhyndoropsis

<i>Encyclia</i> × <i>Cypripedium</i>	= <i>Encyclipedium</i>
<i>Epidendrum</i> × <i>Broughtonia</i> × <i>Laeliopsis</i>	= <i>Moscosoara</i>
<i>Epidendrum</i> × <i>Cattleya</i> × <i>Cattleyopsis</i>	= <i>Hawkesara</i>
<i>Epidendrum</i> × <i>Laelia</i> × <i>Schomburgkia</i>	= <i>Dillonara</i>
<i>Epidendrum</i> × <i>Laelia</i> × <i>Sophronitis</i>	= <i>Stanfieldara</i>
<i>Euanthe</i> × <i>Aerides</i> × <i>Arachnis</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Gilmourara</i>
<i>Euanthe</i> × <i>Aerides</i> × <i>Arachnis</i> × <i>Vanda</i>	= <i>Wrefordara</i>
<i>Euanthe</i> × <i>Aerides</i> × <i>Ascocentrum</i> × <i>Vanda</i>	= <i>Reinikkaara</i>
<i>Euanthe</i> × <i>Aerides</i> × <i>Rhynchostylis</i> × <i>Vanda</i>	= <i>Kamemotoara</i>
<i>Euanthe</i> × <i>Arachnis</i> × <i>Renanthera</i> × <i>Vanda</i> × <i>Vandopsis</i>	= <i>Huntara</i>
<i>Euanthe</i> × <i>Ascocentrum</i> × <i>Ascoglossum</i> × <i>Renanthera</i> × <i>Vanda</i>	= <i>DeWolfara</i>
<i>Euanthe</i> × <i>Ascocentrum</i> × <i>Renanthera</i> × <i>Vanda</i>	= <i>Greatwoodara</i>
<i>Euanthe</i> × <i>Ascocentrum</i> × <i>Renanthera</i> × <i>Vanda</i> × <i>Vandopsis</i>	= <i>Giddingsara</i>
<i>Gomesa</i> × <i>Macradenia</i>	= <i>Macradesa</i>
<i>Gymnadenia</i> × <i>Leucorchis</i>	= <i>Gymleucorchis</i>
<i>Gymnadenia</i> × <i>Platanthera</i>	= <i>Gymnaplatanthera</i>
<i>Gymnadenia</i> × <i>Traunsteinera</i>	= <i>Gymnotraunsteinera</i>
<i>Herminium</i> × <i>Leucorchis</i>	= <i>Herminorchis</i>
<i>Himantoglossum</i> × <i>Orchis</i>	= <i>Orchimantoglossum</i>
<i>Huntleya</i> × <i>Cochleanthes</i>	= <i>Huntleanthes</i>
<i>Ionopsis</i> × <i>Comparettia</i>	= <i>Ionettia</i>
<i>Ionopsis</i> × <i>Oncidium</i>	= <i>Ionocidium</i>
<i>Ionopsis</i> × <i>Rodriguezia</i>	= <i>Rodriopsis</i>
<i>Jacquiniella</i> × <i>Liparis</i>	= <i>Jacquinparis</i>
<i>Kingiella</i> × <i>Doritis</i>	= <i>Doriella</i>
<i>Kingiella</i> × <i>Doritis</i> × <i>Phalaenopsis</i>	= <i>Doriellaopsis</i>
<i>Laelia</i> × <i>Broughtonia</i> × <i>Cattleya</i>	= <i>Laeliocatonia</i>
<i>Laelia</i> × <i>Cattleya</i> × <i>Schomburgkia</i> × <i>Sophronitis</i>	= <i>Herbertara</i>
<i>Laelia</i> × <i>Epidendrum</i> × <i>Schomburgkia</i>	= <i>Dillonara</i>
<i>Laelia</i> × <i>Epidendrum</i> × <i>Sophronitis</i>	= <i>Stanfieldara</i>
<i>Laeliopsis</i> × <i>Broughtonia</i> × <i>Cattleya</i>	= <i>Osmentara</i>
<i>Laeliopsis</i> × <i>Broughtonia</i> × <i>Cattleyopsis</i>	= <i>Gauntlettara</i>

Laeliopsis × Broughtonia × Epidendrum	= Moscosoara
Laeliopsis × Broughtonia × Tetramicra	= Bloomara
Laeliopsis × Cattleya	= Laeliopleya
Laeliopsis × Diacrium	= Dialaeliopsis
Lepanthes × Selenipedium	= Selenipanthes
Leucorchis × Dactylorhiza	= Dactyleucorchis
Leucorchis × Gymnadenia	= Gymleucorchis
Leucorchis × Herminium	= Herminorchis
Leucorchis × Orchis	= Leucororchis
Liparis × Jacquiniella	= Jacquinparis
Lycaste × Maxillaria	= Maxillacaste
Macradenia × Gomesa	= Macradesa
Macradenia × Oncidium	= Oncidenia
Maxillaria × Bifrenaria	= Bifrinlaria
Maxillaria × Lycaste	= Maxillacaste
Miltonia × Aspasia × Odontoglossum × Oncidium	= Withnerara
Miltonia × Brassia × Odontoglossum	= Degarmoara
Mormodes × Catasetum	= Catamodes
Neofinetia × Ascocentrum × Rhynchostylis	= Rumrillara
Odontoglossum × Aspasia × Miltonia × Oncidium	= Withnerara
Odontoglossum × Brassia × Miltonia	= Degarmoara
Oncidium × Aspasia × Miltonia × Odontoglossum	= Withnerara
Oncidium × Ionopsis	= Ionocidium
Oncidium × Macradenia	= Oncidenia
Oncidium × Trichopilia	= Oncidpilia
Ophrys × Cephalanthera	= Cephalophrys
Orchis × Himantoglossum	= Orchimantoglossum
Orchis × Leucorchis	= Leucororchis
Orleanesia × Restrepia	= Restesia
Otostylis × Batemannia	= Bateostylis
Otostylis × Aganisia	= Otonisia

Paraphalaenopsis × Arachnis × Vandopsis	= Garayara
Paraphalaenopsis × Rhynchosstylis × Vanda	= Sweetara
Pattonia × Bromheadia	= Pattoniheadia
Phalaenopsis × Arachnis × Vandopsis	= Laycockara
Phalaenopsis × Ascocentrum	= Asconopsis
Phalaenopsis × Doritis × Kingiella	= Doriellaopsis
Phalaenopsis × Doritis × Rhynchosstylis	= Rhyndoropsis
Phalaenopsis × Renanthera × Vandopsis	= Ernestara
Phalaenopsis × Rhynchosstylis × Vanda	= Yapara
Platanthera × Coeloglossum	= Coeloplatanthera
Platanthera × Gymnadenia	= Gymnaplatanthera
Pteroceras × Renanthera	= Renanthoceras
Renanthera × Aerides × Arachnis	= Lymanara
Renanthera × Aerides × Vanda	= Nobleara
Renanthera × Aerides × Vandopsis	= Carterara
Renanthera × Arachnis × Euanthe × Vanda × Vandopsis	= Huntara
Renanthera × Arachnis × Vanda × Vandopsis	= Teohara
Renanthera × Ascocentrum	= Renancentrum
Renanthera × Ascocentrum × Ascoglossum × Euanthe × Vanda	= DeWolfara
Renanthera × Ascocentrum × Ascoglossum × Vanda	= Shigeuraara
Renanthera × Ascocentrum × Euanthe × Vanda	= Greatwoodara
Renanthera × Ascocentrum × Vanda	= Kagawara
Renanthera × Ascocentrum × Vanda × Vandopsis	= Onoara
Renanthera × Phalaenopsis × Vandopsis	= Ernestara
Renanthera × Pteroceras	= Renanthoceras
Renanthera × Sarcochilus	= Sarcothera
Renanthera × Trichoglottis	= Renaglottis
Restrepia × Orleanesia	= Restesia
Rhinerrhiza × Sarcochilus	= Sarcorrhiza
Rhynchosstylis × Aerides × Euanthe × Vanda	= Kamemotoara
Rhynchosstylis × Aerides × Vanda	= Perreiraara
Rhynchosstylis × Arachnis	= Arachnostylis
Rhynchosstylis × Ascocentrum × Neofinetia	= Rumrillara

Rhynchostylis × Doritis × Phalaenopsis	= Rhyndoropsis
Rhynchostylis × Paraphalaenopsis × Vanda	= Sweetara
Rhynchostylis × Phalaenopsis × Vanda	= Yapara
Rodriguezia × Ionopsis	= Rodriopsis
Sarcochilus × Renanthera	= Sarcothera
Sarcochilus × Rhinerrhiza	= Sarcorhiza
Schomburgkia × Cattleya × Diacrium	= Mizutara
Schomburgkia × Cattleya × Laelia × Sophronitis	= Herbertara
Schomburgkia × Epidendrum × Laelia	= Dillonara
Schomburgkia × Sophronitis	= Schombonitis
Selenipedium × Lepanthes	= Selenipanthes
Serapias × Dactylorhiza	= Serapirhiza
Sophronitis × Cattleya × Laelia × Schomburgkia	= Herbertara
Sophronitis × Epidendrum × Laelia	= Stanfieldara
Sophronitis × Schomburgkia	= Schombonitis
Stenia × Cochleanthes	= Cochlenia
Tetramicra × Broughtonia × Laeliopsis	= Bloomara
Traunsteinera × Gymnadenia	= Gymnotraunsteinera
Trichoglottis × Renanthera	= Renaglottis
Trichopilia × Oncidium	= Oncidpilia
Vanda × Aerides × Arachnis	= Burkillara
Vanda × Aerides × Arachnis × Ascocentrum	= Lewisara
Vanda × Aerides × Arachnis × Ascocentrum × Euanthe	= Gilmourara
Vanda × Aerides × Arachnis × Euanthe	= Wrefordara
Vanda × Aerides × Ascocentrum	= Christieara
Vanda × Aerides × Ascocentrum × Euanthe	= Reinikkaara
Vanda × Aerides × Euanthe × Rhynchostylis	= Kamemotoara
Vanda × Aerides × Renanthera	= Nobleara
Vanda × Aerides × Rhynchostylis	= Perreiraara
Vanda × Arachnis × Ascocentrum	= Mokara
Vanda × Arachnis × Euanthe × Renanthera × Vandopsis	= Huntara

Vanda × Arachnis × Renanthera × Vandopsis	= Teohara
Vanda × Ascocentrum × Ascoglossum × Euanthe × Renanthera	= DeWolfara
Vanda × Ascocentrum × Ascoglossum × Renanthera	= Shigeuraara
Vanda × Ascocentrum × Doritis	= Ascovandoritis
Vanda × Ascocentrum × Euanthe × Renanthera	= Greatwoodara
Vanda × Ascocentrum × Renanthera	= Kagawara
Vanda × Ascocentrum × Renanthera × Vandopsis	= Onoara
Vanda × Ascoglossum	= Vanglossum
Vanda × Paraphalaenopsis × Rhynchostylis	= Sweetara
Vanda × Phalaenopsis × Rhynchostylis	= Yapara
Vandopsis × Aerides × Renanthera	= Carterara
Vandopsis × Arachnis × Euanthe × Renanthera × Vanda	= Huntara
Vandopsis × Arachnis × Paraphalaenopsis	= Garayara
Vandopsis × Arachnis × Phalaenopsis	= Laycockara
Vandopsis × Arachnis × Renanthera × Vanda	= Teohara
Vandopsis × Ascocentrum × Euanthe × Renanthera × Vanda	= Giddingsara
Vandopsis × Ascocentrum × Renanthera × Vanda	= Onoara
Vandopsis × Phalaenopsis × Renanthera	= Ernestara
Zygopetalum × Zygosepalum	= Zygomena
Zygosepalum × Zygopetalum	= Zygomena

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TEOSINTE INTROGRESSION IN THE MAIZE OF THE NOBOGAME VALLEY

BY
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Around Nobogame grows a plant called *maizillo*, or *maizmillo*. It is more slender than the ordinary corn-plant and the ears are very small. It grows among the corn and has to be weeded out, as it injures the good plants. However, several Mexicans assured me that, when cultivated, the ears develop. After three years they grow considerably larger and may be used as food. A man in Cerro Prieto raises this kind only: others mix it with the ordinary corn. I was told that people from the Hot Country came to gather it, each taking away about one almud to mix with their seed corn. The combination is said to give splendid results in fertile soil.

LUMHOLTZ, *Unknown Mexico*
1902

The Nobogame Valley is an isolated valley in the Sierra Madre Occidental of Mexico, and the description by Lumholtz written over fifty years ago is an accurate account of present day hybridization of teosinte with maize.

This valley, inhabited by Tarahumare Indians and Mexicans, is approximately eight miles north of the old mining town of Guadalupe y Calvo in the southwestern corner of the state of Chihuahua. Most of the valley floor is given over to the cultivation of maize, beans and squash or grazed, but teosinte does occur and is often abundant along the margins of maize fields or in the willow thickets bordering the streams. The distribution

of teosinte is limited to probably not more than 25 square miles of the valley between the elevations of 1720 and 1920 meters.

The local inhabitants recognize teosinte as distinct from maize and call it *maicillo* or *maíz silvestre*. They are also familiar with the maize×teosinte hybrids and universally will claim that if the hybrid is cultivated for three years it produces maize. Some feel that hybridization even improves the maize.

Factors limiting gene exchange

Both teosinte and maize are wind-borne, cross-pollinated plants, and the prevention of hybridization with subsequent genetic exchange between the two species is dependent on (1) the spatial isolation of the two species, (2) the seasonal isolation of the two species, (3) the lack of fitness of the hybrid, and (4) the types of selection operating on the two parental populations.

The most effective isolating mechanism in most areas where teosinte and maize are sympatric has been the mean mid-flowering date, with maize flowering 2-5 weeks ahead of teosinte. Nobogame teosinte is unique in that it is the only teosinte population found in a habitat other than a cultivated field which is not seasonally isolated from maize. Maize of the Nobogame Valley is a five month type belonging to the race Cristalino de Chihuahua which is planted in May and harvested in September before the early killing frost. Both teosinte and maize reach mid-flowering in August.

Hybridization at Nobogame

In all the areas of both Guatemala and Mexico where teosinte and maize occur together there is some evidence (only a single F₁ hybrid in some cases) of hybridization, but never has the author found such a large number of hybrids and clear and unmistakable effect of teosinte in-



Maize of the Nobogame Valley. Cristalino de Chihuahua is a poorly defined race in Mexico which is typically a dent corn. There is considerable variation from field to field and very hard flinty kernels are frequent in the region where hybridization with teosinte occurs. 2/5 actual size.

trogression in maize cobs as exists in Nobogame. The abundance of F_1 hybrids is comparable to Chalco, where several researchers have studied maize $\times$ teosinte hybrids (López y Para (1908), Collins (1921), Bukasov (1926, 1930), Mangelsdorf (1952), and Wilkes (1967)). Unlike the region around Chalco, however, teosinte is not limited to the cultivated fields. Teosinte also occurs in dense stands along the streams and in areas protected from grazing on the surrounding hills.

Although all the fields had been harvested at the time of the field work (November), careful investigation indicates that maize $\times$ teosinte hybrids are present in the fields proper, but not as abundant as they are on the margin of the maize fields or in the willow thickets along the stream. When maize $\times$ teosinte hybrids are encountered in the maize fields of Mexico, it is usually presumed that they are from teosinte fruit-cases containing hybrid seed which were naturally disseminated in the field. In Nobogame, the female parent of the teosinte $\times$ maize hybrids is sometimes maize and thus the hybrids are often planted in the field.

Teosinte introgression

The evidence of teosinte introgression into maize is clearly seen in maize cobs throughout those parts of the valley where teosinte is most abundant. At harvest time the entire ear is brought to the granary, and for several weeks thereafter the ears are left to air dry in large piles around the courtyard. A sector of each of twenty piles representing twenty distinct fields of eight cultivators was studied. Twenty-five cobs were separated from the pile and shelled. Approximately $\frac{1}{4}$ of all the cob samples expressed the tripsacoid characteristic of a pronounced induration of the rachis and lower glume. All of the piles possessed tripsacoid cobs (Wilkes, 1968), although

a few of the samples were free of tripsacoid cobs.

Two of the fields where tripsacoid cobs had been harvested were visited and teosinte was found to be abundant around the field margin. Although most of the teosinte plants had dispersed their seed and were dried and broken, several F_1 hybrids were located which still possessed intact cobs. In one field, two teosinte backcross progeny of the F_1 maize $\times$ teosinte hybrids were discovered, indicating that there is some reciprocal introgression.

Despite the presence of reciprocal introgression, most of the gene flow is from teosinte to maize. Teosinte is a wild plant possessing the ability to disperse its seed as single rachis segments, while domesticated maize has a massive cob tightly enclosed by a husk system. Only those teosinte backcross segregates which possess the genetic control for a disarticulating rachis are able to disperse their seed. This factor is primarily responsible for the unidirectional flow of genetic material. The backcrosses to teosinte that segregate a more maize-like cob with non-disarticulating rachis disperse the entire spike as a whole. The numerous seed all germinating still attached to the cob are so crowded that they either choke each other out or develop into numerous spindly plants that fail to flower. In both cases, the genetic inheritance of the maize-like cob is lethal to a plant dependent on natural dispersal of its seed for survival. The selection for the disarticulating teosinte pistillate spike and distribution of single seeds protected by a rachis-segment, along with a large population of wild plants in the surrounding region, appears to act against the effects of maize introgression on the pistillate spike of teosinte.

Study of maize ears

The evidence for introgression of tripsacoid characters from teosinte is objectively measurable in the morpholo-

PLATE LXXVI. Evidence of teosinte introgression and maize $\times$ teosinte hybridization. A. The cob to the far left is a typical maize ear and shows evidence of introgression of tripsacoid segments associated with chromosome 9, and possibly chromosome 4. The cobs to the right are arranged in a series of increasingly pronounced tripsacoid characteristics. The extreme is the cob to the far right with its massive lower glumes and deep cupules. This cob, which was part of the maize harvest, is comparable in morphology to a maize backcross to the maize $\times$ teosinte hybrid. 7/10 actual size. B. This F_1 maize $\times$ teosinte hybrid came from the same field as the cobs in A. Note the two-ranked rachis, the paired spikelets, and the kernels forcing open the enclosing lower glumes; all typical characteristics of the F_1 hybrid. 7/10 actual size.

gy of the maize cob (Galinat et al., 1956; Sehgal, 1963). The presence of a short, thick rachilla inclined to the axis, pronounced glume cushions, slightly upcurved glumes, comparatively soft rachis tissue, and well developed central pith in the maize cobs of the fields suggests the introgression of segments of chromosome 9, and possibly chromosome 4, of teosinte.

Eight ears selected by the cultivator as seed ears from a field where maize×teosinte hybrids were known to be abundant were studied. These very productive ears were not highly tripsacoid, but they too showed evidence of teosinte introgression (rigid cob, straight rows, and indurated glumes). Four of these ears were shelled and 100 seeds from each ear were grown. Three cobs yielded all maize plants, but the fourth produced three maize×teosinte hybrids. This frequency of three maize×teosinte hybrids per 400 plants compares well with the number of maize×teosinte hybrids estimated to be present in the field and the abundance of highly tripsacoid cobs found in the total harvest.

Maize×teosinte hybrid seed on the predominantly maize-pollinated ear can not normally be distinguished morphologically from pure maize. Yet at Nobogame several ears from the same field were selected from the total pile because they possessed smaller than usual seeds. These small seeded ears uniformly yielded maize×teosinte hybrids when planted. It was found that if the ear is pollinated only by teosinte, the hybrid seeds are smaller than the few hybrid seeds found on a predominantly maize-pollinated ear. Thus there appears to be a chemical feed-back mechanism (growth hormone?) between the developing seed and the cob. This postulated hormone might act to stimulate the conduction of food through the cob to the developing seed.

Controlled pollinations of teosinte on the corn inbred

A158 have produced seeds which are smaller and weigh less than self pollinated A158. This phenomena is not universal because controlled pollinations of teosinte on the New England Flint, Wilburs Flint, produced hybrid seed which are indistinguishable in size and weight from self-pollinated Wilburs Flint.

Discussion

Maize and teosinte are fully fertile, and in the Nobogame Valley the two hybridize naturally. Maize $\times$ teosinte hybrids are known from other regions in Mexico and Guatemala, but Nobogame is unique because hybrids are in some cases cultivated because the inhabitants feel they improve the maize and in others the hybrids are unknowingly planted in the maize fields.

Wild teosinte is abundant in the region, and hybrids are almost as abundant in the fields as on the margin of the fields. Because the method of cultivation of maize has not changed appreciably in the last hundred years this pattern of an abundance of teosinte hybrids on the seed ears is suspected to have been widespread in the past in regions where it is almost extinct today. Such a pattern of hybridization with teosinte would account for the widespread tripsacoid characteristics now found in the races of maize on the Central Plateau (Wellhausen et al., 1950) and adjacent regions. This hybridization in the past would also explain why the teosinte of the Central Plateau is one of the most maize-like races of teosinte.

The observations of the incorporation of teosinte segments from chromosome 9, and possibly 4, are interesting also because Sehgal (1963) has shown that, under experimental conditions, incorporation of teosinte chromosomes 9 and 4, either alone or in combination, in a uniform maize-inbred, increases the length of the cob. It is pos-

PLATE LXXVII

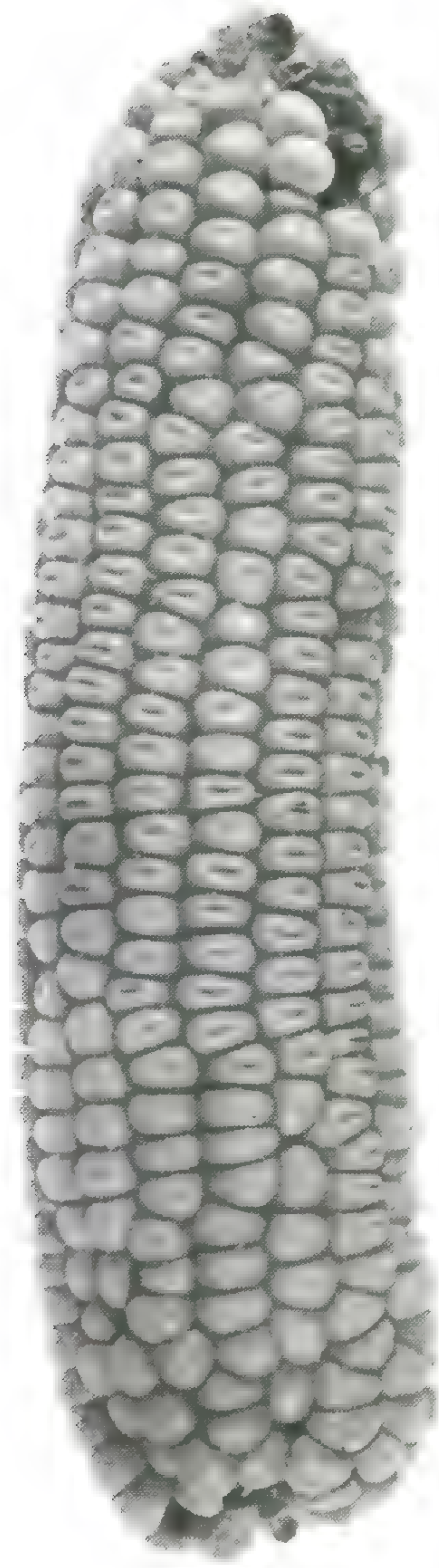


Evidence of tripsacoid characters in Nobogame cobs. A. These maize cobs are from a typical field where hybridization with teosinte was known to occur. Actual size. B. The short, thick rachilla inclined to the axis, the slightly upcurved glumes, and the pronounced glume cushions suggest the introgression of tripsacoid segments on chromosome 9, and possibly chromosome 4, from teosinte. The rachis tissue is comparatively soft and the central pith is well developed. $3\times$ actual size.

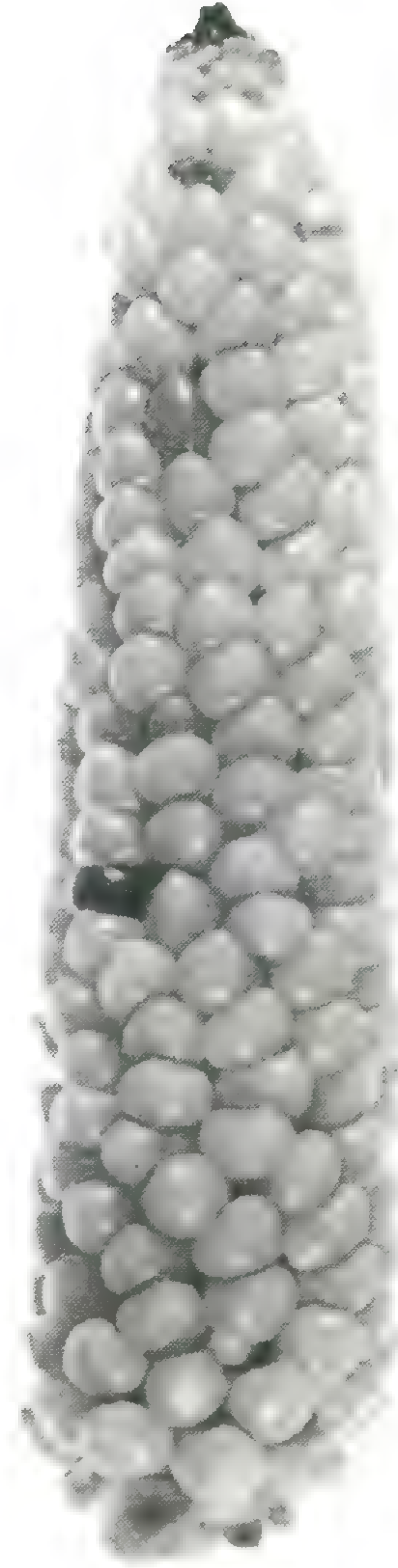
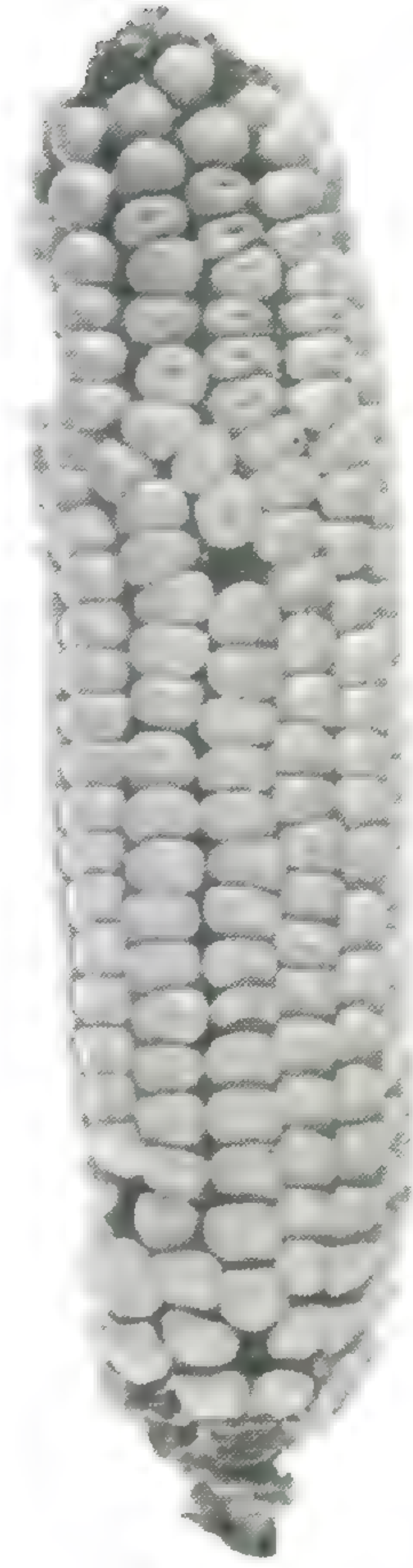
tulated that, since increased cob length is selected for in seed ears, teosinte hybridization is of positive selection value in the maize of Nobogame.

Summary

1. A detailed analysis of the maize fields was made in the Nobogame Valley in southwestern Chihuahua, where the pattern of cultivation for maize has not changed appreciably in the last one hundred years. The maize grown around Nobogame is a five month type belonging to the race Cristalino de Chihuahua. The teosinte belongs to the race Nobogame and is abundant along the margin of maize fields and growing wild in the non-cultivated parts of the valley.
2. Maize and teosinte are not seasonally isolated as they are at most other sites where the two occur together. The mid-flowering times overlap in August and maize $\times$ teosinte hybrids occur naturally. Teosinte pollen is sufficiently abundant at flowering that many pollinations on maize cobs are by a teosinte parent. Seed ears of maize have been shown to be contaminated by teosinte pollen resulting in the actual planting of maize $\times$ teosinte hybrids by the cultivator.
3. The cobs of the maize planted in the valley show pronounced signs of tripsacoid germ plasm such as induration of the lower glume and a straight rigid cob. These characteristics are attributed to the introgression of tripsacoid genes via direct hybridization with teosinte followed by subsequent introgression from maize and teosinte backcross progeny. The maize backcross progeny are usually harvested while the teosinte backcross progeny are usually left standing in the field. Although introgression is reciprocal,



A



B

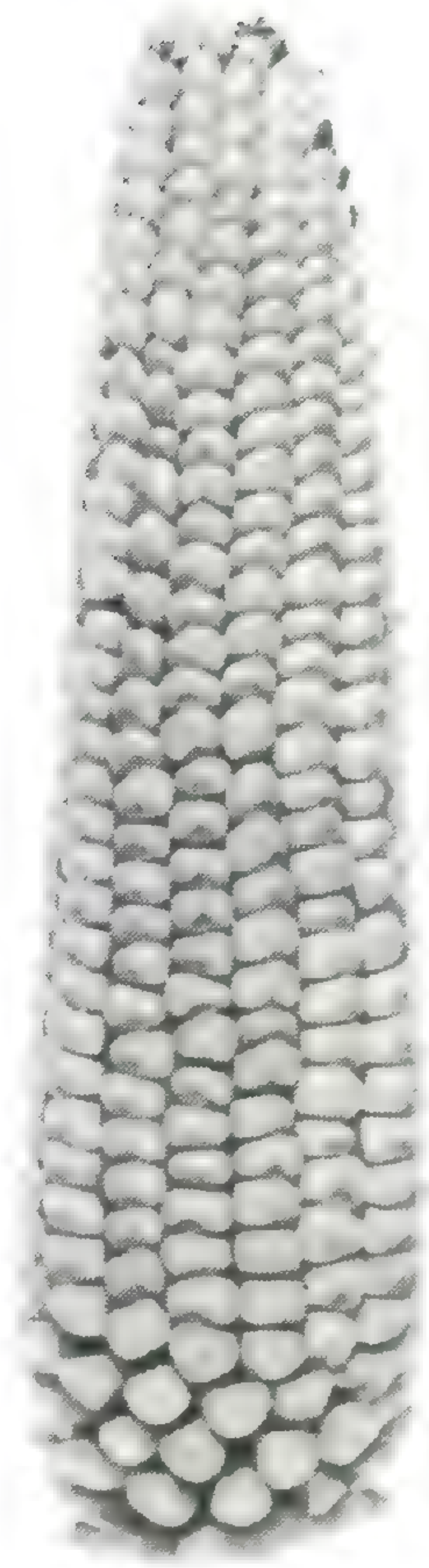


PLATE LXXVIII. Teosinte-pollinated maize ears.

A. When the maize ear is pollinated only by teosinte, the hybrid seed are smaller than the few hybrid seed found on a predominantly maize pollinated ear, which are indistinguishable from the pure maize seed. The ear to the left is the inbred A158 and the ear to the right is a controlled pollination of teosinte pollen on the ear of A158. 7/10 actual size. B. These ears are open pollinated ears from Nobogame. The seed are of normal size on the ear to the left. The seed shelled from the ear to the right are smaller and all produced F_1 maize $\times$ teosinte hybrids. If the entire ear is pollinated by teosinte, none of the hybrid seed develop to the size of a normal maize kernel. This dwarfing effect only occurs if the entire ear is made up of hybrid kernels. Note also the tendency of the hybrid kernels to produce pointed seed, a character often found in pop corns. 7/10 actual size.

the main flow of genes appears to be from teosinte to maize, since the genetic incorporation of a maize-like rachis results in the inability to disperse seed and the extinction of these maize introgressed teosinte plants.

4. It is postulated that the hybridization of teosinte and maize on the Central Plateau in the past is comparable to the present hybridization of teosinte and maize at Nobogame. This hypothesis accounts for both the widespread presence of tripsacoid characteristics in the maize of the Central Plateau and the maizoid characteristics of the teosinte. The introgression of teosinte segments following maize×teosinte hybridization would have been of positive selection value if it resulted in a larger ear.

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EARLY EIGHT-ROWED MAIZE FROM THE MIDDLE RIO GRANDE VALLEY, NEW MEXICO

BY

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AND THEODORE R. FRISBIE³

A MUTUAL interest of the maize phylogenist (senior author) and the archaeologist (junior authors) in the pre-historic spread of the eight-rowed race of maize, Maíz de Ocho, has made this and several other similar studies possible. Their respective interests, however, lie in different aspects of the same problem. The evolutionary history of Maíz de Ocho involves the origin of the Corn Belt dent as well as many sweet corn varieties and its understanding could lead to the synthesis of even more productive strains in the future. It is an archaeological artifact of certain Indian cultures. The distribution of this race may also reveal some of the history of its possessors.

In an earlier study it was found that the dates for this

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eight-rowed race generally became older toward the Southwest (Galinat and Gunnerson, 1963). A continuity in its distribution between the Plains and the Southwest was established by the discovery of sites for Maíz de Ocho in Chacuaco Canyon in southeastern Colorado (Galinat and Campbell, 1967). The date of A.D. 1140 for this Colorado material leaves unsolved the problem on direction of spread because now the slightly older dates of A.D. 1040 have been discovered for this race at the Blain Site in Ohio (Galinat, 1969) and of A.D. 1125 ± 70 at the Miller Site in Ontario (Kenyon, 1968).

Documentation of the spread of Maíz de Ocho, like that of other cultural artifacts, depends upon the discovery of its oldest possible remains at certain critical locations. The present report on the oldest Maíz de Ocho yet discovered in North America has, therefore, particular significance in revealing the spread of this race of maize.

The radiocarbon dates herein reported were determined gratuitously by Dr. Henry F. Nelson of the Research Laboratory of the Mobil Oil Corporation, Dallas, Texas. The date of 18 ± 138 B.C. (SM 1021) at the BR-45 Site came from an indirect association in debris between some wood and the cobs of Maíz de Ocho. The shallow and homogeneous nature of this debris seems to rule out any significant disparity between the age of the cobs and that of the analyzed wood. The more recent date of A.D. 370 ± 168 (SM 1018) at Boca Negra Cave for this eight-rowed race came from wood which was charred in the same hearth with the cobs. At the third location for Maíz de Ocho discussed here, the Artificial Leg Sites, the dates of A.D. 550 to A.D. 700 for the cobs of this race were determined by combining data from ceramic analysis, palynology and archaeomagnetism (Frisbie, 1957).

THE LOCATIONS AND CULTURAL PHASES OF THE SITES

THE BR-45 SITE

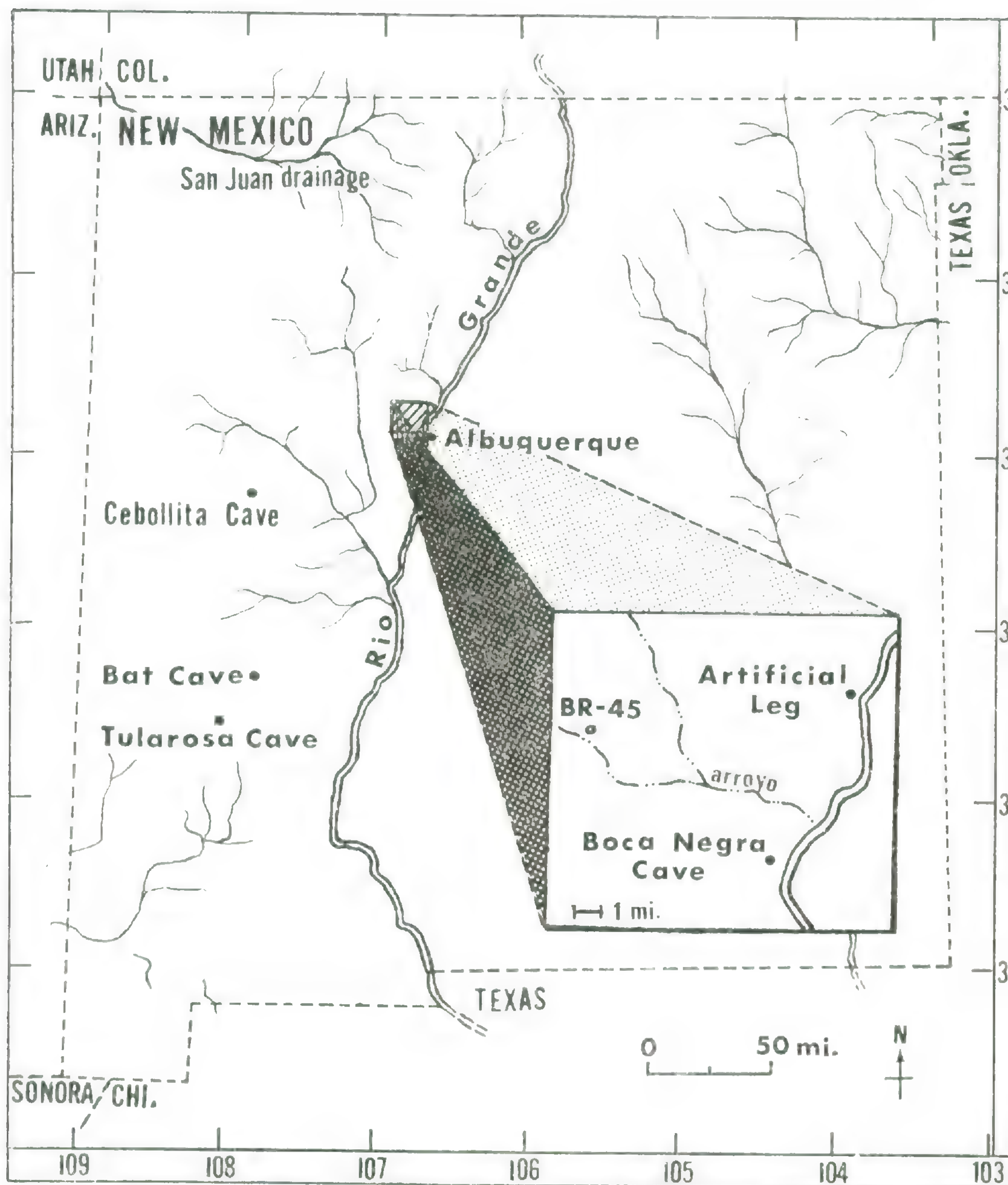
The BR-45 Site is located on the west mesa at 6100 feet about $12\frac{1}{2}$ miles west of the Rio Grande River at Albuquerque, New Mexico, while the Boca Negra Cave and Artificial Leg Sites are elevated at about 5100 feet on the first terrace closer to the river. The other maize-containing sites previously reported in central New Mexico are on the same western side of the river and to the southwest of the Middle Rio Grande Valley (Plate LXXIX).

The west mesa is now dissected by arroyos sloping in a west-to-east direction toward the river. The arroyos cut through dune-covered ridges which were the occupation sites. During a number of wetter years than at present, maize was probably grown on the flood plains where these more modern arroyos now occur.

The BR-45 Site occupies the south slope of one of the sandy ridges just below its crest. It consists of two small pithouses with outside living areas to the east of the dwellings, as described in detail by Reinhart (1967a).

The cultural affinities at the BR-45 Site were of the Alameda Phase which is an early Basketmaker III manifestation. Its identification is based on typological comparisons, including ceramics, to known Basketmaker III material. These identifications (Reinhart, 1967a) suggest that the dunes were stabilized approximately 2000 to 1500 years ago during a period of increased moisture. This dating also appears to fit the moist period postulated as being between the Fairbank and Whitewater droughts (Antevs, 1955) as well as the radiocarbon date of 18 ± 138 B.C. for the BR-45 maize, as will be described later.

PLATE LXXIX



The enlarged insert shows the three site areas, BR-45, Boca Negra Cave, and Artificial Leg, which are studied in this paper. Other maize-containing sites in New Mexico are indicated to the southwest of this Albuquerque area.

BOCA NEGRA CAVE

Boca Negra Cave is situated on the northeast side of a volcanic cone near the city of Albuquerque. The cave measured $27\frac{1}{2}$ feet deep, $20\frac{1}{2}$ feet wide and 6 feet high before excavation. The details of the excavations are described by Reinhart (1968).

Because the terrain around the cave and for a mile to the river is rocky and otherwise unsuited for agriculture, the site probably never had a permanent agricultural settlement. Nevertheless a long record of maize and other artifacts was left apparently by migrants who camped at the cave for a short time and then moved to other Basketmaker III agricultural sites along the river such as those at Artificial Leg.

The stratigraphy at Boca Negra Cave has a bearing on our understanding of the evolution of southwestern maize. Its succession includes material which is both older at the lower level and more recent at the upper level than that found at the BR-45 Site. The earliest culture present was of the late Atrisco Phase (Campbell and Ellis, 1952) which dates prior to 1000 B.C. and is a local Cochise manifestation. While incipient agriculture may have been practiced, there is no direct evidence of it either at Boca Negra Cave or at the west mesa sites at this early time. The Atrisco Phase is preceramic and is represented here only by lithic tools. While the next Phase, Rio Rancho, was also preceramic, it contained cobs of Chapalote, the indigenous race of the Southwest and Mexico which will be described later. Both the ceramics and a new race of maize, Maíz de Ocho, appear in the Alameda Phase, an early Basketmaker III culture dated at A.D. 370 ± 168 at the Boca Negra Cave Site. This stratigraphy extending over a 3000 year period together with the racial identity of the maize present are given in Table III.

THE ARTIFICIAL LEG SITES

The three excavated Artificial Leg Sites are also located near the river about 12 miles north of Boca Negra Cave and just to the west of Sandoval (Corrales), New Mexico (Frisbie, 1967). The initial settlement of Site I occurred during the same drought period around A.D. 550 when Maíz de Ocho was introduced into the already established culture of Boca Negra Cave. The settlers at Artificial Leg also appear to have migrated from their original home on the mesa (BR-45) to these sites near the river in order to have moist soil necessary for the growth of their maize.

The shelters at these Middle Rio Grande Valley sites were pithouses. Their structure coincides more closely with that of the Mogollon custom in the South than with that of the Anasazi of the North. They were nearly circular in outline with either a flattened or concave east side. The roofs were usually supported by four posts. Floor features consisted of a centrally located, circular, collared hearth, deflectors, ash pit, ladder holes, and an easterly oriented ventilator shaft. Other floor features included depressions and storage pits, many widened at their bases.

At Artificial Leg, each site consisted of a group of at least four such pithouses. One of these structures was larger than the others, being 26 feet in diameter rather than the approximately 16 feet commonly found. This larger pithouse, more properly termed "kiva," served ceremonial purposes, as indicated by its *sipapu* or "opening to the underworld," by its foot drums and by its location apart from the other pithouses. The development of these ceremonial structures again reflects Mogollon customs.

The appearance of the new productive races of maize,

Maíz de Ocho and Pima Papago, with the Mogollon type of pithouse, especially the ceremonial type, indicates that the two may have diffused together from the South. The short tenure of these races on the mesa which was terminated by drought may not have allowed time for the elaboration of appropriate ceremonialism.

The evidence from ceramics at these sites near the river indicates contacts with both the southern and northern cultures. Potsherds from the Alma Plain which originated with the Mogollons from the South were found with mineral and carbon painted affiliates of Lino Gray representing Anasazi wares from the North. While the data on ceramics do not in themselves verify the route of Maíz de Ocho, they do reveal that trade was well established between the South and North. This new race of maize would probably have been included in some of the transactions.

THE MAIZE

Chapalote is the indigenous race of maize of the area. It traces back to preceramic times during the Rio Rancho phase at Boca Negra Cave. About 125 miles to the south at Bat Cave, New Mexico, Chapalote was dated at 2300 B.C. where its evolution eventually involved a second element, the wild relative teosinte, at 500 B.C. (Mangelsdorf and Smith, 1949; Mangelsdorf et al., 1967).

Chapalote may be identified either by its kernels or by its cobs. Its kernels are deeper than wide in shape and generally small and flinty although a floury form was selected in Basketmaker times. Its cupules (depressions in the cob axis (rachis) immediately above the attachment point of each pair of pistillate spikelets) are narrow (3 to 4 mm. wide) and the width and height (internode length) are usually of about equal dimensions. Evolved Chapalote has 12 to 16 rows of kernels while the earliest

TABLE 1.
MAIZE FROM THE BR-45 SITE, NEW MEXICO

Sample Number	No. Kernel Rows	w=Cupule Width(mm)	λ -Internode Length(mm)	Cupule Shape w/ λ	Race
BR-45/M1-1	12*	5.6	3.5	1.6	Pima Papago
" -2	12	5.3	3.2	1.7	" "
" -3	12	5.4	3.5	1.5	" "
" -4	12	5.6	3.6	1.6	" "
BR-45/M2	8*	6.0	3.0	2.0	Maíz de Ocho

*Row number estimated on the basis of cob fragments consisting of at least two parallel rows of cupules.

w/ λ = cupule width/cupule internode length.

Chapalote, such as that from Bat Cave, has eight kernel rows. The race Reventador is very similar to evolved Chapalote except for having colorless instead of brown pericarp. Because no distinction between Reventador and Chapalote was possible in this archaeological material, the name of the older race, Chapalote, is used.

The race of particular concern, Maíz de Ocho, was the third major element involved in the evolution of maize in the Southwest. Previously this race was thought to have arrived in New Mexico at about A.D. 700, the date of its earliest remains at Tularosa Cave (Cutler, 1952). Apparently it appeared at about the same time 90 miles northward at Cebollita Cave (Plate 23 F of Galinat and Ruppé, 1961). The earlier dates of 18 ± 138 B.C. for Maíz de Ocho 75 miles to the northeast at BR-45 and A.D. 370 ± 168 at Boca Negra Cave do not negate the overall evidence for a southern origin. The next oldest date for this race is A.D. 200-850 previously reported for a site in Tamaulipas, Mexico (Mangelsdorf et al., 1967). The Tamaulipas material may be on a parallel pathway leading to the Davis Site in Texas which had this eight-rowed race at A.D. 800-1000 (Jones, 1949). The Maíz de Ocho ancestral to that from the Albuquerque area of New Mexico more probably came directly through Chihuahua and Sonora, as indicated by four caves in these Mexican states yielding prehistoric remains of this race (Mangelsdorf and Lister, 1956). Apparently southern United States had multiple connections through the Sierra Madre Occidental of northern Mexico from some common source, perhaps on the west coast of southern Mexico. Maíz de Ocho is thought to have been derived originally from Colombia, South America (Galinat and Gunnerson, 1963).

The kernels and cob of Maíz de Ocho are distinctive from those of Chapalote. They occur in only eight rows

(borne in pairs at four ranks of cupules) instead of the 12 to 16 rows which characterize the older race. The shape of kernel is also different, being wider than deep rather than deeper than wide. In addition, the shape of the cupule is definitive. The ratio of cupule width/internode length is about two in Maíz de Ocho in contrast to the more narrow cupules of Chapalote, especially near the tip of the cob where the ratio is close to one.

THE MAIZE FROM THE BR-45 SITE

The maize from BR-45 consisted of five broken and eroded cobs. The kernel row number, cupule width and internode length of these specimens was measured in order to establish their racial identity (Table I). One of the cobs represented the race Maíz de Ocho and the other four were from its hybrid, Pima Papago. The eight-rowed cob could be a segregate out of the hybrid. In any case the hybrid was most abundant. The early acceptance of the hybrid may be due to its rapid adaptation through the segregation of favorable genes from its indigenous parent, Chapalote. The increased vigor and productivity associated with such a wide cross must have promoted its spread, probably far ahead of the Maíz de Ocho parent.

The cultivation of the productive races of maize, Maíz de Ocho and Pima Papago by the people at BR-45 seems to have bound their way of life to farming. Serving these people as a major source of food, they became dependent upon it. Subsequently after a protracted dry period they abandoned the mesa for sites nearer the river which provided the moist soil necessary for the growth of their maize. After abandonment, the cobs of Maíz de Ocho and Pima Papago and other debris on the ridge sites became buried under the sands of time until the present excavation. Previously when their ancestors with

TABLE II.

MAIZE FROM BOCA NEGRA CAVE, NEW MEXICO

Sample	No. Kernel Rows	Cupule Width(mm)	Internode Length(mm)	Cupule Shape w/l	Race
BB-1/M1-1	12	3.5	3.5	1.0	Chapalote
" -2	12	4.0	2.8	1.4	Chapalote Mix
" -3	12	5.0	3.2	1.6	Chapalote Mix
" -4	12	3.5	3.5	1.0	Chapalote
BB-1/M2	10	6.5	3.0	2.2	Maíz de Ocho
BB-1/M3	12	4.6	3.0	1.5	Maíz de Ocho Mix
BB-1/M4-1	10	6.5	3.7	1.8	Maíz de Ocho
" -2	14	9.5	5.3	1.8	Pima Papago
BB-1/M5-1	c. 10	5.0	3.6	1.4	Maíz de Ocho Mix
" -2	c. 10	5.5	3.5	1.6	Maíz de Ocho Mix
BB-1/M6-1	c. 10*	5.7	4.2	1.4	Maíz de Ocho Mix
" -2	c. 8	5.4	4.0	1.1	Maíz de Ocho Mix
" -3	c. 8	5.6	4.1	1.4	Maíz de Ocho Mix
" -4	c. 8	5.5	4.1	1.3	Maíz de Ocho Mix
BB-1/M7-1	12	4.6	4.0	1.2	Chapalote Mix
" -2	12	3.1	3.1	1.0	Chapalote
" -3	12	3.2	3.2	1.0	Chapalote
BB-1/M8-1	c. 12	3.5	3.5	1.0	Chapalote
" -2	c. 12	3.4	3.5	0.97	Chapalote
"	c. 12	3.1	3.3	0.94	Chapalote
BB-1/M9-1	c. 10*	6.5	2.6	2.5	Maíz de Ocho
" -2	c. 12*	7.3	3.0	2.4	Pima Papago
" -3	c. 10*	6.0	3.3	1.8	Maíz de Ocho
" -4	c. 12*	5.3	3.6	1.5	Pima Papago
BB-1/M10-1	c. 10	6.7	4.2	1.6	Maíz de Ocho Mix
" -2	c. 6	8.1	4.6	1.8	Maíz de Ocho Mix
BB-1/M11	c. 14	4.5	4.5	1.0	Chapalote

*Row number estimated on a basis of fragments consisting of at least two parallel rows of cupules.

c. - carbonized cob.

less productive food plants encountered similar drought conditions on the mesa, they merely adapted by shifting their subsistence patterns to include more wild food rather than seek a more suitable farming area.

The early radiocarbon date (18 ± 138 B.C.) and the major cultural traits at BR-45 indicate that the races of maize, Maíz de Ocho and Pima Papago, located there were originally derived from the southern Mogollon culture rather than from the Anasazi of the San Juan drainage area to the North. That is, the age of the Basketmaker cultural level at BR-45 and the other nearby sites discussed in this paper is intermediate between that of the older Mogollon cultures of the South and the more recent San Juan cultures of the North. This suggests that the Middle Rio Grande Valley was an area of transition from South to North.

THE MAIZE FROM BOCA NEGRA CAVE

Before the introduction of Maíz de Ocho, the indigenous race of maize, Chapalote, occurred in Basketmaker II (preceramic) times about twelve miles away toward the river at Boca Negra Cave. Later the people presumably moving from the drying mesa area (BR-45) left their Maíz de Ocho and Pima Papago maize during the early Basketmaker III period (the end of the Alameda Phase). The radiocarbon date of A.D. 370 ± 168 for this new maize at the cave is a jump of over 400 years over that reported for its collection at BR-45, only $12\frac{1}{2}$ miles away but 1000 feet higher on the west mesa.

There were 24 eroded cobs, eight of which had been carbonized, from Boca Negra Cave. The excavation was in stratigraphic layers from the surface to a depth of 40 inches. The cobs represent two distinct races, Chapalote and Maíz de Ocho and their hybrid, Pima Papago, as well as some intermediate types classified as "mixed"

TABLE III

THE STRATIGRAPHY AND MAIZE FROM BOCA NEGRA CAVE						
Phase of Cultural Association	Maize Sample Number BB-1	Race of Maize				
		Chapalote	Chap. mix.	Pima Papago	M. de O. mix.	Maíz de Ocho
Pueblo IV to Historic	M1	2	2	0	0	0
Pueblo IV	M2	0	0	0	0	1
Pueblo III to IV	M3	0	0	0	1	0
Pueblo II to IV	M4	0	0	1	0	1
Early Alameda ¹	M9	0	0	2	0	2
Rio Rancho to Alameda	M5	0	0	0	2	0
" " " "	M6	0	0	0	4	0
Rio Rancho to Early Alameda	M8	3	0	0	0	0
Rio Rancho ²	M7	2	1	0	0	0
Atrisco ³	-	0	0	0	0	0

1 - Early Basketmaker III, dated A.D. 370 $\pm$ 168

2 - Basketmaker II, preceramic

3 - Local Cochise, no direct evidence for agriculture prior to 1000 B.C.

Two additional maize samples (BB-1/M10 and BB-1/M11) of unknown cultural association are not included.

which probably represent the backcross or segregating progenies derived from the hybrid. The typical hybrid type (Pima Papago) combined the higher kernel row number (12 rows) of Chapalote with the wider cupules (6 to 10 mm.) of Maíz de Ocho. When the mixed modification is toward Maíz de Ocho, the specimen is scored as Maíz de Ocho Mix. When the direction is that of Chapalote, it is identified as Chapalote Mix. The data upon which the races and forms were identified and the phase of cultural association for the various specimens are given in Tables II and III.

THE MAIZE FROM THE ARTIFICIAL LEG SITES

All of the 13 cob fragments of maize from the Artificial Leg Sites were completely carbonized. Ten of these came from Site I dated at A.D. 550 to A.D. 700, two from Site II dated at A.D. 750 to A.D. 800, and one from Site III dated at A.D. 870 to A.D. 930. The hybrid race, Pima Papago, predominates and the larger collection (Site I) contains a few specimens similar to its parents, Chapalote and Maíz de Ocho. The latter appear to be parental-type segregates from the hybrid rather than independently derived pure entities (Table IV).

Pima Papago is presumed to have been more successful at first than its introduced parent, Maíz de Ocho and, thereby, to have traveled northward from the Sierra Madre Occidental at a faster pace. It is unfortunate that more specimens were not available from Site III. The single specimen available was of a modified form of Maíz de Ocho which may well represent a segregate from the hybrid.

Apparently in the more northerly climates natural selection favors the eight-rowed derivatives. Further north across the boundary into southeastern Colorado, the Chapalote type segregates almost disappear while

TABLE IV
MAIZE FROM THREE SITES AT ARTIFICAL LEG, NEW MEXICO

Sample Number	No. Kernel Rows	Cupule Width(mm)	Internode Length(mm)	Cupule Shape w/ λ	Race

Site I, Pithouse 6, West Cist Floor: A.D. 550 to A.D. 700

BAL-35/1	14	6.9	3.0	2.30	Pima Papago
" 35/2	12	5.9	3.0	1.96	Pima Papago
" 35/3	12	4.5	3.2	1.43	Chapalote
" 35/4	8	10.0	3.2	3.10	Maíz de Ocho
" 35/5	12	5.1	3.5	1.46	Pima Papago
" 35/6	14	4.8	3.4	1.41	Chapalote Mix
" 35/7	10	5.2	3.6	1.45	Pima Papago
" 35/8	14	3.8	2.0	1.90	Pima Papago
" 35/9	16	5.9	3.0	1.97	Pima Papago
" 35/10	12	4.9	3.1	1.58	Chapalote

Site II, Pithouse 4, Fill: A.D. 750 to A.D. 800

BAL-35/11	12	5.5	3.5	1.57	Pima Papago
" 25/12	14	5.7	3.7	1.54	Pima Papago

Site III, Pithouse 1, Fill: A.D. 870 to A.D. 930

BAL-35/13	10	6.1	2.7	2.26	Maíz de Ocho Mix
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Maíz de Ocho germplasm predominates. Here in the Chacuaco Canyon area, Chapalote was reduced to only two percent while Maíz de Ocho occurred at 22.8 percent, Maíz de Ocho Mix at 36.9 percent and the intermediate hybrid type (Pima Papago) at 36.3 percent from a total of 201 cobs (Galinat and Campbell, 1967). As the distribution progressed onto the Plains and north-eastward, the frequency of pure Maíz de Ocho increased. Nevertheless, even the northern flints may exhibit some degree of Chapalote germplasm derived from their ancestral mixing in the Southwest such as is manifest by the flinty kernels or the occasional kernel row numbers of over eight.

SUMMARY

The radiocarbon date of 18 ± 138 B.C. is the earliest North American date yet reported for the introduced race of maize, Maíz de Ocho, or its hybrid, Pima Papago, involving the indigenous race, Chapalote. The early date comes from the BR-45 Site about $12\frac{1}{2}$ miles to the west and 1000 feet higher than the Albuquerque area of the Middle Rio Grande Valley, New Mexico. Older remains of the original pure form of Maíz de Ocho probably will be discovered in Chihuahua and Sonora, perhaps near the valleys draining to the west coast of Mexico. From there, it is presumed to trace to South America where it has botanical affinities with the Colombian race, Cabuya (Roberts et al., 1957). The early presence of the hybrid Pima Papago in New Mexico rather than the pure Maíz de Ocho parent can be attributed to an increased adaptability, vigor and productivity associated with outcrossing to the indigenous race, Chapalote. The eight-rowed parent remains in a semi-hybrid condition in the form of Harinoso de Ocho in northwestern Mexico (Wellhausen et al., 1952), while it has assorted out to an

increasing pure race as it spread onto the Plains and to the Northeast in its well known forms of northern flour and northern flint. The presumed Colombian ancestor, Cabuya, is a highland race, and this might account for some pre-adaptation to high altitudes and northern latitudes in United States, as exemplified by the early distribution of Maíz de Ocho (Galinat and Gunnerson, 1963).

The Maíz de Ocho from the BR-45 Site was moved by its cultivators to sites with moist soil along the river after a protracted dry period made the mesa unsuitable for the growth of their maize. At the lower elevations, it became further mixed with the older indigenous race, Chapalote, in Basketmaker III times at the end of the Alameda Phase. The radiocarbon date of A.D. 370 ± 168 marks the introduction of this eight-rowed maize into the strata at Boca Negra Cave. A somewhat later date of A.D. 550 to A.D. 700 follows for this race just north of Albuquerque at the Artificial Leg Sites. By A.D. 1040 Maíz de Ocho had reached the Blain Site in Ohio (Galinat, 1969) and by A.D. 1125 ± 70 the Miller Site in Ontario (Kenyon, 1968). While the frequency and purity of Maíz de Ocho increased during its spread to the Northeast, some traits of Chapalote derived from an ancestral mixing in the Southwest may still be recognized in the Canadian and New England flint corn varieties.

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ETHNOGYNECOLOGICAL NOTES IN THE HARVARD UNIVERSITY HERBARIA

BY
SIRI VON REIS ALTSCHUL

PLANTS used by primitive societies for the maintenance or restoration of health have drawn the attention of medical researchers in modern times. Those species which, however vaguely, have offered hope for relief from cancer, heart disease, mental illness and diverse metabolic disorders have aroused probably greatest interest up to the present. Among the plants which remain for the most part unexplored as to their pharmacological potentials are species which have been employed in connection with the functions and diseases of the reproductive tract of the human female. As a branch of ethnomedicine, this field might be called ethnogynecology. I use the term here to include, as well, ethnoobstetrics, embracing the practices surrounding pregnancy, labor and the puerperium in primitive cultures.

A number of species of plants previously little known for their involvement in ethnogynecology recently has been brought to light as the result of a large-scale search carried out during the last decade at Harvard University. This paper is one among several which have dealt with medicinal folklore in general,¹ with psychopharmacology,² with unusual food plants³ and with plants used to treat children's diseases,⁴ all based on data retrieved from the survey.

In 1962, Dr. Richard Evans Schultes and I set up a search for botanical folklore of potential interest to health and medical sciences.* Projects with this objective are not new. Ethnobotanical information has been gathered traditionally from both old and new writings in anthropology and botany, from archaeological materials and from field work. We believe that our project was unique in that it relied exclusively on mainly unpublished data from labels accompanying herbarium specimens. In five years, a sheet by sheet examination of over 2,500,000 specimens of flowering plants in the combined herbaria of the Arnold Arboretum and Gray Herbarium of Harvard University was completed. These specimens span a century and a half and are worldwide in representation. From these repositories the harvest amounted to nearly 7,000 notes from over 5,000 species. Materials ranging from magic to chemistry were recorded there, wherever was some hint of the presence of biodynamic agents. All species were checked in Uphof's *Dictionary of Economic Plants*⁵ in order to eliminate from our compilation already well known uses. One exception which was made to this procedure was in conserving any note which extended the geographic representation of a known use.

The search was undertaken in the belief that the major herbaria of the world represent untapped reservoirs of vital data. In some instances, they might provide the only remaining clues to the *materia medica* and nutritional

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patterns of peoples now extinct or whose cultures have been absorbed or destroyed by civilization. In other instances, they might serve to point out species which have not been used by man but which, on the basis of field observations, lead one to believe that they could be developed as economic plants. It was felt that the accelerating expansion of urbanization and forced constriction of natural areas make it urgent to gather and study all possibly useful species before living representatives in nature inadvertently are extinguished.

Out of the entire body of notes extracted from the herbarium search, about 100 notes fall within the class of ethnogynecology as defined above. These 100 or so notes represent as many field collections and nearly as many species. It is likely that many additional species from our notes are employed for the same purposes but are unrecognizable as such on the basis of the field notes alone. For example, in the newly completed index to our notes, there are over 400 species described only as "medicinal plants". There are almost 200 species which are reputed analgesics. Some 85 species are used for stomach disorders. Increasingly fewer numbers are employed as astringents; against abdominal spasms; as aphrodisiacs; for treating anemia; in baths; and as anti-convulsants.

Of the roughly 100 notes which are the concern of this paper, 38% have to do with the period after labor known as the puerperium. Twenty-one per cent relate to treatment of venereal disease, not always indicating, it must be acknowledged, whether for males or females. Eleven per cent deal with menstruation. Nine per cent refer to "female disorders". Eight per cent have to do with labor or childbirth. Another 8% relate directly to birth control. The remainder concerns galactagogues and plants used during the course of pregnancy. Needless

to say, some notes overlap more than one category.

Fifty families of flowering plants are represented among these notes. Thirty of these families have yielded one note each, which suggests a scattered distribution of ethnogynecological uses among the flowering plants. Twelve families produced two notes each. The *Boraginaceae* and *Labiatae* are represented each by three notes, the *Gramineae* by four, the *Liliaceae* five notes. The *Leguminosae* had six, *Euphorbiaceae* eight, *Compositae* 12 and *Rubiaceae* 13.

At least 35% of the plants are said to be eaten or, in some form, drunk. Sixteen per cent are made into decoctions or infusions, most of which probably are also orally administered. Fourteen per cent are employed externally, including in baths. Two per cent are inserted vaginally. Thirty-three per cent of the notes do not reveal the modes of employment.

Seventy per cent of the ethnogynecological notes indicate the parts of plants used. Roots are said to be used in nearly half of these notes. Leaves are designated in almost a third. The rest of the notes cite, in order of decreasing importance, barks, the entire plant, fruits, flowers and latex.

Of the 87 genera represented among these ethnogynecological notes, 33 are virtually unknown economically. Three quarters of the species are similarly unknown for economic purposes of any sort.

I should like to cite some of the field notes associated with species of economically obscure genera. As already stated, the largest group of ethnogynecological notes concerns the puerperium. In this category, sundry species can be cited from the Philippine Islands. For example, *Schizostachyum Lumampao* (C. O. Frake 567, *Gramineae*) and *Kadsura scandens* (C. O. Frake 578, *Schisandraceae*) are used as postpartem medicines. The

roots of *Knema glomerata* (C. O. Frake 569, *Myristicaceae*) and *Phytocrene Blancoi* (C. O. Frake 502, *Icacinaceae*) are boiled and drunk during puerperium. The roots of *Melicope monophylla* (C. O. Frake 674, *Rutaceae*) are pounded and drunk, while those of *Aphana* sp. (C. O. Frake 38140, *Icacinaceae*) are applied in some manner. The bark of *Neonauclea formicaria* (C. O. Frake 566, *Rubiaceae*) is boiled and drunk. The genus *Cyrtandra* (C. Cumingii, R. B. Fox 5052; *Cyrtandra* sp., M. D. Sulit 9974, *Gesneriaceae*) is used in association with bleeding following childbirth. A noteworthy claim is made for an indeterminate species of *Polyosma* (M. D. Sulit 3443, *Saxifragaceae*): "Decoction of roots given to women who gave birth—after delivery women can immediately walk—according to native".

From South America, one might cite *Tournefortia brevilobata* (W. H. Camp 2560, *Boraginaceae*): in Ecuador, "Infusions of lvs. drunk by women a day or two after childbirth to 'clean everything out'".

In association with the puerperium, one could include reputed galactagogues, such as *Epigynum Maingayi* (Ismail & Millard s.n.: K. L. No. 187, *Apocynaceae*) from Malaya. From Indochina, the following was reported for *Desmos Hancei* (Poilane 1184, *Annonaceae*): "... les Indigènes... emploient les rameaux et feuilles pour faire un breuvage qu'ils font prendre au femme après accouchement pour augmenter la sécrétion lactée, ils donnerait également des fruits comestibles".

The second largest group of ethnogynecological notes gathered relates to venereal disease. At least two species are represented from the Solomon Islands: *Faradaya* sp. (S. F. Kajewski 2543, *Verbenaceae*) "... in common with other vines is used for gonorrhea, the bark is macerated with water, the resulting concoction being drunk". *Cremastus sceptrum* (Williams & Assis 7343, *Bignonia-*

ceae) is supposed to be the source of a root-derived syrup “Good for syphilis”.

There are various examples from the New World: in El Salvador, *Campelia sanonia* (*P. C. Standley 19320, Commelinaceae*) is a “Remedy for gonorrhoea”. In Bolivia, *Pothomorphe peltata* (*J. Steinbach 5536, Piperaceae*) is used “. . . contra llagas sipiliticas”. Three species may be included from Mexico: *Mascagnia septentrionalis* (*G. Thurber 901, Malpighiaceae*) was used at least a century ago, the root being a putative specific against syphilis. A “remedy for gonorrhoea” comes from *Ageratum conyzoides* (*P. C. Standley 19220, Compositae*). The macerated leaves of *Hintonia latiflora* (*G. B. Hinton Herb. No. 3413, 4317, Rubiaceae*) are taken internally for malaria and pinto. Pinto, or pinta, is the common name in Mexico for a form of treponematosi, an infection closely related to venereal syphilis.

In Africa, there is *Sabicea Vogelii* (*G. F. S. Elliot 4175, Rubiaceae*) “Used for gonorrhea by Natives. . .”

The third and fourth largest categories of ethnogynecological notes pertain to menstruation and “female disorders”, respectively. These notes deserve special attention. The plants in question apparently are *used* to treat what appear to be, for the most part, routine functional and minor ailments. But there is the possibility that at least some of these plants *act*, in fact, as regulators of reproductivity. As unrecognized birth control agents—for instance, as abortifacients or promoters of fertility—these species would be of considerable interest in connection with human population studies.

Plants in this category include *Polia thyrsifolia* (*C. Drake 491, Commelinaceae*) in the Philippine Islands: “Leaves applied for amenorrhea”.

In the West Indies, *Tournefortia volubilis* (*S. Kings 140, Boraginaceae*) is “Used for female trouble”. Here,

too, *Eleutherine bulbosa* (D. Taylor 30, *Iridaceae*) is “. . . used as a cure for irregular menstruation and menopause”. In Peru, *E. plicata* (F. Woytkowski 5744) produces bulbs from which a decoction is made for treating hemorrhages. *Bulbostylis capillaris* (W. A. Archer 4931, *Gramineae*) from Paraguay is “Sold by herb dealers in market at Asunción . . . as blood purifier in female disorders”. In El Salvador, *Polypremum procumbens* (Dr. A. Van Severen s.n., *Loganiaceae*) is believed to be a “Remedy for ‘metritis’”.

There are three Mexican *Compositae* of interest: *Haplopappus spinulosus* (Dr. Gregg 6) over a century ago was decocted for “. . . disorders of uterus detention of catamenia”. *Franseria ambrosioides* (H. S. Gentry 1336) was used as recently as 1935 for “female trouble”, the roots being cooked in water. In the same year, it was reported of *Viguiera montana* (H. S. Gentry 1288) that “Women put leaves on stomach to cause menses to flow, ‘por sale la sangre’”.

Perhaps of greater interest to students of fertility are those few species which are claimed directly to be able to control human reproduction. These species represent the sixth largest category of ethnogynecological notes. They are included at this point, out of sequence, because of their relationship with the two foregoing categories. One might cite here *Vochysia lomatophylla* (F. Woytkowski 6021, *Vochysiaceae*), collected in Peru in 1960: “. . . perhaps used by Campa tribe as contraceptive?”. In the *Compositae*, *Iostephane heterophylla* (H. S. Gentry 6349) was reported from Mexico in 1941 to have tuberous roots “. . . decocted for medicine; makes women fertile”.

The fifth largest category of ethnogynecological notes is made up of plants administered during labor, or in childbirth. To here, all examples cited have come from

genera scarcely known for their utility to man in any context. Those which follow represent genera which already enjoy economic standing of some sort but whose herein named uses are not widely known.

A number of examples is to be found from the Philippine Islands. An indeterminate species of *Loranthus* (*G. E. Edaño 1999, Loranthaceae*) bears leaves which are pounded in a mortar and applied to the stomach before childbirth. *Glochidion cauliflorum* (*M. D. Sulit 3297, Euphorbiaceae*) is used as follows: "Decoction of roots mixed with roots of cacao and coffee given to women for quick delivery". An "... infusion of the roots ..." of *Ocimum sanctum* (*G. E. Edaño 1618, Labiatae*) "... is given to mothers for childbirth". The use of *Ocimum* reminds one of recent work on *Nepeta Cataria*⁷ and *Salvia divinorum*,^{8,9} both also mints. The last two genera appear to contain psychopharmacological constituents. Is it possible that *Ocimum* may produce a similar intoxication and be used in primitive childbirth somewhat as the plant-derived hypnotic scopolamine has been employed in modern labor?

Two species in the *Leguminosae* might be cited from the Caroline Islands: *Pterocarpus indicus* (*C. C. Y. Wong 419*) produces leaves which are pounded to fine particles and applied for vaginal ruptures. Women "... express the leaves ..." of *Phaseolus adenanthus* (*C. C. Y. Wong 302*) "... and drink the sap for labor pains".

In Ecuador, *Heliotropium argenteum* (*F. Prieto 2555, Boraginaceae*) is employed to prepare an "Infusion of leaves given to women who have fits and spasms during childbirth". This genus has been recorded previously as possessing medicinal properties but not, to my knowledge, as an antispasmodic.⁵

The smallest category of ethnogynecological notes relates to pregnancy. It encompasses only two species,

from the *Gramineae*. *Pennisetum alopecuroides* (C. O. Frake 512) from the Philippine Islands has roots which are “. . . applied to stomach to reduce size in pregnancy (!)” *Cyperus brevifolius* (S. F. Kajewski 276) is used in the New Hebrides Islands, where it is macerated with other plants and drunk for good health during pregnancy.

I should not leave this subject without a word on aphrodisiacs. They have not been included among ethnogynecological notes. Possible aphrodisiacs number possibly fewer than 15 among all notes from the herbarium search. Perhaps the most intriguing entry is little known *Centropogon calycinus* (Y. Mexia 7701, *Campanulaceae*): in Ecuador, it is “Used as a love potion”. *Mallotus Poilanei* (M. Poilane 26084, *Euphorbiaceae*) belongs to a medicinal genus⁵ but is reported from Indochina as having a “Racine tonique et aphrodisiaque”. *Jatropha angusti* (J. West 3796, C. Vargas C. 408, *Euphorbiaceae*), also from a medicinal genus,⁵ is reputed to be an aphrodisiac in Peru. *Ptychopetalum olacoides* (G. Stahel 269, *Olacaceae*) is supposed in Surinam to act as an aphrodisiac; the species also is the source of Muira puama, employed in medicine.⁵

Among alleged love charms are species of the genera *Loranthus* (*Loranthaceae*), *Aristolochia* (*Aristolochiaceae*), *Canavalia* (*Leguminosae*), and *Premna* (*Verbenaceae*). Sundry common names suggest aphrodisiacal properties: among these I have included plants called “Love Bush”, “Amor Seco” and “Matrimonio Viejo”.

There is one antaphrodisiac: of *Davilla lacunosa* (L. O. Williams 5098a, *Dilleniaceae*) in Brazil, it is said: “Give tea to animals and they are impotent”.

In conclusion, I want to say that species of plants associated with ethnogynecology warrant careful inspection by modern gynecological and obstetrical pharmacologists. I would emphasize further that, in considering

these species, one must also expand one's view of their possible usefulness beyond the purposes for which they are employed in the simplistic contexts of their ethnobotanical origins. Today we can cure venereal disease; we have anodynes for dysmenorrhea and synthetic opiates for labor. The major value of the notes referred to may lie in how they might bear incidentally upon such fields as cancer, heart, mental and metabolic research. It is in such a questioning posture that we hope to present these and all our materials to science in a forthcoming catalogue.

Today, not even ten years after our first thoughts on searching herbaria, we inevitably ask whether it is not imperative to attempt now—perhaps through the international cooperation of various scientists and governments—to preserve living examples of all extant species, including economic and presently non-economic plants. I take this opportunity to recommend that coordinated efforts to this end would be particularly fruitful in the so-called underdeveloped nations where, it so happens, one encounters the most promising of ethnobotanical raw materials, directly from the indigenous societies which give birth to their uses. If civilized man does not act now, he may leave his descendants irretrievable losses and, possibly, the undoing of his own species through want of some missing botanical essential to a future generation.

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DE PLANTIS TOXICARIIS E MUNDO
NOVO TROPICALE COMMENTATIONES VII

SEVERAL ETHNOTOXICOLOGICAL NOTES
FROM THE COLOMBIAN AMAZON

BY
RICHARD EVANS SCHULTES

MANY of our ethnotoxicological observations made amongst Indians of the northwest Amazon indicate interesting uses of plants the genera of which have never been chemically investigated. The several species discussed below fall very definitely into this category and would seem to represent areas profitable for phytochemical enquiry.

These notes are a continuation of investigations into poisonous plants of the New World tropics which I have been carrying out since 1941 and which is currently being supported by a grant from the National Institutes of Health (No. LM-GM00071-01).

The voucher specimens cited are preserved in the Gray Herbarium, the Arnold Arboretum and the Economic Herbarium of Oakes Ames of Harvard University or in the Herbario Nacional Colombiano. The illustrations were prepared by Mr. Josua B. Clark and the late Mr. John Stanwell-Fletcher.

ARACEAE

No chemical studies appear to have been carried out on the genus *Urospatha*. The juice from the rhizome of

a Brazilian species—*Urospatha caudata* Schott—is used medicinally in the treatment of skin troubles (Peckholt, T.: Pharm. Rundschau 10 (1892) 279, 11 (1893) 379).

***Urospatha sagittaeifolia* Schott** Aroid. (1853) 4.

COLOMBIA: Comisaría del Amazonas, Río Amazonas, Leticia and vicinity. “In swamp. Spathe green externally, white-green within. Stem mottled brown-green. Height 6 feet.” August 29–September 12, 1966. *R.E. Schultes, R.F. Raffauf et D. Soejarto 24039*.

A field spot test with modified Dragendorff reagent indicated that *Urospatha sagittaeifolia* is alkaloid-positive.

***Urospatha somnolenta* R. E. Schultes** in Bot. Mus. Leaf. Harvard Univ. 18 (1958) 123.

COLOMBIA: Comisaría del Vaupés, Río Kuduyarí, Cachivera de Itapinema. August 14, 1960. *R.E. Schultes 22589*.

This is the second collection referable to *Urospatha somnolenta*. Like the plant from the type locality, *Schultes 22589* grew alongside a quartzitic rapids in swampy holes in the rock. The locality of this second collection belongs geologically to the same formation as the type locality.

The Kubeo Indians at Yapobodá consider the root of *Urospatha somnolenta* to be toxic if ingested, yet the ashes of the entire plant are employed medicinally in the form of a poultice on ulcers and infected cuts. The Kubeo name of the plant is *ö-mě'-na*.

MYRSINACEAE

***Conomorpha citrifolia* Mez** in Engler Pflanzenr. 4 Myrsin. (1902) 256.

COLOMBIA: Comisaría del Vaupés, Río Paraparaná, Raudal Na-hoo-gaw-hě. “Flowers whitish yellow. Small tree along bank.” September 1952. *R.E. Schultes & I. Cabrera 17593*.

The Puinave Indians, some of whom have migrated into the Apaporis basin, call this treelet *yoom-dá-ka* and rasp the bark into *chicha* to impart to it a rather peppery taste. It is recommended also as a febrifugal tea.

APOCYNACEAE

Ambelania Lopezii *Woodson ex R.E. Schult.* in Bot. Mus. Leaflet. Harvard Univ. 15 (1951) 76.

COLOMBIA: Comisaría del Vaupés, Río Guainía, below San Antonio, Caño del Loro. “*Molongó*. Flowers white, fragrant. Growing at edge of water.” June 1948. *R.E. Schultes et F. López* 10132.—Comisaría del Vaupés, Río Kananarí, Cachivera Palito. “Bush. Flowers fragrant, white.” July 25, 1951. *R.E. Schultes et I. Cabrera* 13175.—Río Apaporis, Raudal Yayacopí (La Playa) and vicinity. “Small tree. Flowers white, very fragrant. Latex white.” August 18, 1952. *Schultes et Cabrera* 16968.—Río Piraparaná, middle course. “Four meters tall. Flowers white, fragrant.” September 1, 1952. *Schultes et Cabrera* 17135.—Río Piraparaná, Caño Teemeeña. “Large bush. Flowers white, fragrant. Latex white.” September 6, 1952. *Schultes et Cabrera* 17245.

The Barasana Indians boil the leaves of this bushy treelet with the bark of *Distictella racemosa* and *Martinella obovata* to make one of their arrow poisons.

Amongst the related Makunas of the same area, who know this plant as *wy-gare-ñö-mee'-kö*, it is apparently not employed for this purpose but reputedly as a fish poison.

BIGNONIACEAE

Distictella racemosa (*Bur. & K. Schum. ex Mart.*) *Urban* in Fedde Repert. 14 (1916) 310.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratema (above mouth of Río Kananarí) and vicinity. Alt. about 900 feet. “Liana. Flowers cream-white. July 31, 1951. *R. E. Schultes et I. Cabrera* 13215.—Same locality. “Woody vine. Flowers white. Barasana name = *mee-tsee-boo-koo'-na*.” January 28, 1952. *R.E. Schultes et I. Cabrera* 14990.

The bark of *Distictella racemosa* is one of the ingredi-

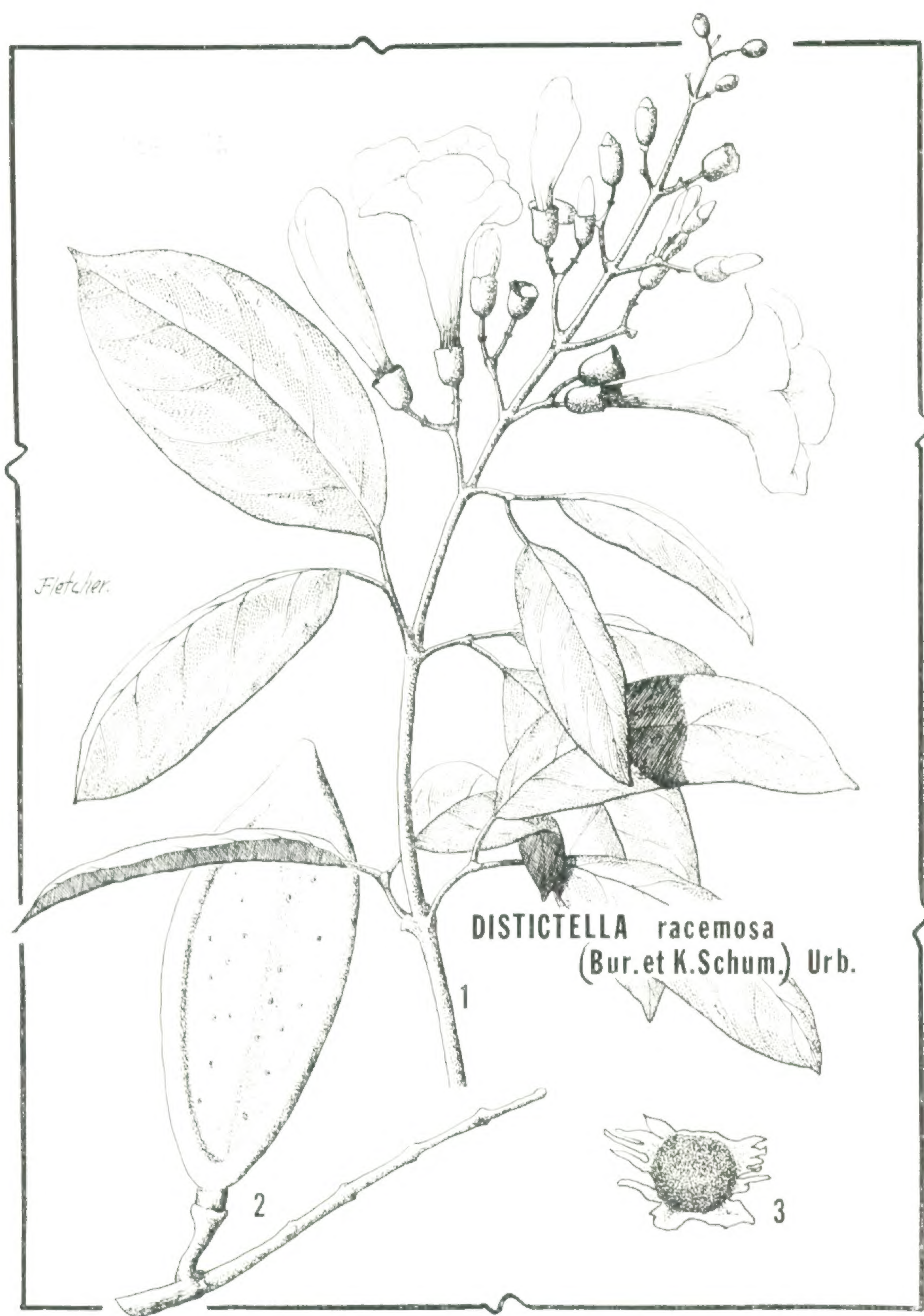


PLATE LXXI



Ambelania Lopezii Woodson in a flooded caatinga near the confluence of the Ríos Guainía and Negro, Colombia.

Photograph: R. E. SCHULTES



ents of a type of curare prepared by the Barasana Indians living on the Río Apaporis near the mouth of the Kananarí. The other plants said to be used in this preparation are the leaves of *Ambelania Lopezii* and the bark of *Martinella obovata*. The root of *Distictella racemosa* is reputedly very toxic.

Martinella obovata (*HBK.*) *Bureau et K. Schumann ex Martius* Fl. Bras. 8, pt. 2 (1897) 161.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama (near mouth of Río Kananarí). January 28, 1952. *R.E. Schultes et I. Cabrera* 14994.

The bark of *Martinella obovata*, together with the leaves of *Ambelania Lopezii* and the bark of *Distictella racemosa*, is utilized by the Barasana Indians in elaborating on arrow poison. An infusion of the bark is said to be a febrifuge but dangerous to use.

PLATE LXXXIII



MARTINELLA obovata (HBK) Bur. & K. Schum.

JBC